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1. On the identification of the ancient town of Tagara.

By Md. Abdul Aziz. *Communicated by the Joint Philological Secretary.*

Several towns have been identified with Tagara, and Dr. Fleet's dictum (Ter) appears to have been accepted as final. But I venture to reopen the question as I have formulated a theory concerning it from the facts mentioned by Ptolemy and Arrian.

I summarise below the points on which, in my opinion, the identification of Tagara should be based in accordance with the details given by Ptolemy and Arrian, as also on certain facts of historical importance concerning it.

(i) That Tagara was situated to the north of the river Godavari.

(ii) That Tagara and Paithan were the two principal marts in the Deccan, and that all kinds of merchandise throughout the Deccan were brought to Tagara, and from there conveyed on carts to Broach.

(iii) That the manufactures of the East Coast (Kalinga) were taken to Tagara.

(iv) That on the advent of the Greeks in the Deccan, some time before the Christian era, Tagara was the metropolis of a large district.

(v) That native traditions point to some ancient city near Nander and Dharampuri on the Godavari as the first capital of the country.

(vi) That it is well known that, in the middle of the first century A.D., the seat of his kingdom was removed from Tagara to Paithan by Raja Salivahana, and this was done to enable him to be better able to stem the tide of invasion from the north by the Parthian satraps of Guzerath.

(vii) That it was 10 days' journey east of Paithan.

On the strength of these points of identification, I identify Nagram, a small village in the Sironcha Tahsil of the Chanda District, C.P., and situated just at the confluence of the rivers Pranhita and Godawari, with the ancient Tagara.

I will now work out my theory.

(i) Nagram is situated on the northern bank of the river Godawari. No other town attempted to be identified with Tagara fulfils this condition.

(ii and iii) All the other towns identified except Kolhapur are within a radius of about 100 miles from Paithan to the north, west and south. Of all these places Ter (The Tagara of Dr. Fleet) is perhaps a little nearer the east coast than Paithan. Ptolemy and Arrian state that the manufactures of the east coast were taken to Tagara, and thence were conveyed on carts to Broach. Paithan and Ter are situated almost on the same line north to south. Traffic from Ter to Broach must pass through Paithan. A glance at the map will bring home this fact. But the ancient authors mention that merchandise was conveyed from Tagara to Broach direct and not through Paithan, which was an independent and separate trade centre. This proves that Tagara must have been situated somewhere to the east, north or west of Paithan and not on the trade route leading from the east coast to Paithan. It could not be to the north or south as in that case this presumption would militate against the assertion of the ancients that the manufactures of the east coast were brought to Tagara; Paithan would be nearer, and commerce would naturally gravitate to the nearest market and distributing centre.

These considerations preclude the idea of Tagara being situated to the north, west and south of Paithan and its neighbourhood. Nagram satisfies all the conditions mentioned by Ptolemy and Arrian. It is about 250 miles right to the east of Paithan, and pleasantly situated for a trade centre at the junction of two great water courses. It is much nearer the east coast than Paithan and other identified places, and is easily approachable from the east coast in all seasons, being connected with it by the river Godawari which is navigable to native craft all the year round. It is at too long a distance from Paithan to interfere with the development of both as emporiums of commerce. Ter and other places are too near Paithan to admit of their successful development and becoming principal marts.

(iv and vi) About the beginning of the Christian era, the Greeks found Tagara the capital of a kingdom. No other interpretation can be put on the phrase "Metropolis of a district." Paithan is not mentioned as occupying such a position.

It is an accepted historical occurrence that Raja Salivahana removed his capital from Tagara to Paithan in the first century, A.D., to enable him to be better able to stem the tide of invasion from the north by the Parthian satraps of Guzerath. This historical fact will lose its value and import if any one of the towns claiming identification is admitted to this distinction. There can be no meaning in the transfer of the seat of Government from one place to another within such a short radius when the object for which the removal was effected is considered. The tide of foreign invasion could be as easily checked from the several places in the proximity of Paithan as from Paithan itself. But the transfer from Nagram would be justifiable and reasonable on all grounds. It is too far to the east to enable one to control the operations on the frontier somewhere in Berar for chastising the foreign invaders in those times of slow and laborious communication.

(v) Native traditions in the country around Nagram point to it as the capital of king Salivāhana. In the vicinity of Nagram there are four towns—Kaléshwar, Chinnoor, Mantheni, and Dharampuri—that are old seats of Brahmin learning and culture. In these places Nagram has the reputation of being the locality famous for the exploits of the Potter King. There the learned pandits refer to Nagram as the capital of Raja Salivāhana even in common talk. Nagram is historically asserted as the capital of Raja Salivāhana.

Traditional evidence is thus entirely in favour of Nagram being the ancient Tagara.

(vii) The Greeks mention Tagara as 10 days' journey east from Paithan. Here the expression "10 days' journey" cannot be accepted in its literal sense rigidly. In olden times before the advent of the railway travelling was measured by stages, each stage being supposed to be covered in a day. Stages were never fixed to be equidistant, but the convenience to be obtained at each stage or halting place governed the motive about their fixation. The idea was that the halting place for the day should be in a locality where the travellers could procure travelling requisites if necessary together with the general necessaries of life. Consequently some stages were extraordinarily long, others exceptionally short.

Again, the military stage is vastly longer than the commercial stage or the pilgrim's stage, and it cannot be definitely guessed as to which stage is meant here. The expression is vague, and no importance can be attached to it except to the direction mentioned. Nagram is right to the east of Paithan.

Besides these seven data for identification there are two other points which I would like to dilate upon.

(1) The present name " Nagram " of the place.
(2) The mention of Tagarapura, etc., in the inscriptions of the sixth and seventh centuries, A.D.

(1) Nagram is the Telugu form of Sanskrit nagar which means a city. It is absurd to dub a small hamlet of 100 or 150 huts a city without any prefix to denote the name of the founder or something about its foundation as is generally the case. How came an obscure village like Nagram to be called a city—pure and simple ? This question can be solved in one way only. It is a remnant of its ancient greatness. The colloquial appellation has remained to signify its past existence. I will explain my idea from two modern examples.

The people of the territory around Hyderabad call it simply ' Shahar ' = city or Patnam (in Telugu) = city. In private correspondence also it is mentioned as such. In ages to come Hyderabad will remain in the common parlance of the country as ' shahar ' or ' Patnam ' and no more.

Pataliputra is the ancient name of Patna. Patna means a city. People of the surrounding country called it Patna in the days of its greatness and glory, and the same common appellation remained attached to it even after it fell and was lost to history.

(2) Tagara was the first capital of the first historical dynasty of the Deccan. Naturally it came to be regarded as the seat and embodiment of political power and greatness by the people, and a halo of past splendour and glory grew round it as centuries rolled on even after it had ceased to be a metropolis. This sentiment must have gained support also from the great shrine of Kalishwar that is separated from Nagram by the river Godawari and which is an important place of Hindu pilgrimage. It is a characteristic of Indians that they attach importance and greatness to every thing ancient and enveloped in legendary mist and try to connect themselves with it in some way or other. You will find every Sardar of the Maratha country trying to trace his descent from the followers of Shivaji and every respectable Muhammadan family in the U.P. and Deccan claiming hereditary connections with the dignitaries of the Great Moghals. Similarly every subsequent dynasty in the Deccan attempted to show themselves off as the successors of the great dynasty, hence the expression " Lord of Tagarapura," etc.

On the grounds and reasons discussed above I identify the modern Nagram with the ancient Tagara.

2. A Progress Report on the Work done during the year 1917 in connection with the Bardic and Historical Survey of Rajputana.

By Dr. L. P. Tessitori.

General Remarks.

During the year under review the progress of the work has been regular and satisfactory, for which not a small part of credit falls on the sympathetic and unfailing support of the Bikaner Darbar. The only difficulty experienced was due to insufficient personnel, but this insufficiency depended on unfavourable circumstances which could not be remedied, and on the other hand the difficulty affected myself, in that it made my task heavier, rather than the progress of the work. Certainly the exploration of the district could have been more extensive if a traveller had been available for all the twelve months of the year, but in other respects I think I can say that the work suffered no hitches.

At the beginning of the year I had two employees: an assistant in the person of Bāraṭha Kisora Dāna, whose services had been kindly lent to the Survey by the Jodhpur Darbar since July 21, 1916; and an explorer in the person of Vīṭhū Sītā Rāma. But early in April the Jodhpur Darbar intimated that they desired Bāraṭha Kisora Dāna to revert to his former duties in the *Tawārikh Mehkma* at Jodhpur, and so I lost him at the end of the same month. The man, in spite of his complete ignorance of Sanskrit and English and his inaptitude for critical work, was a great help to me in going through bardic manuscripts, as of all the bards I know he is the one who can understand the meaning of old songs best. Therefore his loss was a great blow to me, and all the more so in that I have been unable to replace him. The profession of a bard having long ceased to be lucrative and even remunerative, it has been so much neglected during these last years that the very sons of those who were honoured by the title of *kavirāja* twenty or thirty years ago, now hardly understand Ḍiṅgaḷa better than an ignorant Italian peasant can understand the Latin of his Church. Happily, the more I become familiar with the bardic literature, the more easily can I afford to do without an assistant, but the amount of work increases as I have to do all by myself.

The explorer Sītā Rāma discharged his duties almost uninterruptedly, though with much slackness during the summer months, from January 1st to about the end of September, when he fell a prey to that terrible fever epidemic which ravaged this part of the desert after the rains. The fever disabled him for over two and a half months, and it was only on December 15th that he rejoined my service. As I had previously realized that a single explorer was not sufficient for a State of so vast a territory as Bikaner, I soon found that my difficulties were enormously increased by the temporary loss of the only man I had, and lost no time in looking for two additional explorers. These, however, could not be found until December 6th, and December 13th, and both of them had hardly finished their training by December 31st. Their names are: Sā̃dū Jora Dāna of Vīkāsara, and Bāraṭha Deva Karaṇa of Mathāṇiyā̃. It is now proposed to keep all the three explorers working simultaneously not only in order to make up for the time lost during the last year, but also in order to complete as soon as possible the whole exploration of the Bikaner territory.

A copyist was employed for two months only, during September and October, after which the post of a copyist was definitely abolished as it imposed upon me a continuous surveillance and in spite of all my efforts would never give satisfactory results. Following a suggestion by Sir George A. Grierson, I have now made arrangements for the acquisition of a rotographical apparatus, which will enable me to copy manuscripts in facsimile, thereby saving time and avoiding errors of amanuenses.

When in consequence of the new arrangement concluded in co-operation with the Archaeological Survey of India, in August 1916,[1] I was entrusted with the collection of materials for the compilation of a list of the archaeological remains in the Bikaner State, I had thought I could easily do the archaeological exploration of the district simultaneously with the search for manuscripts and inscriptions which I was making in connection with the Bardic and Historical Survey. A few months' experience, however, soon taught me that I was mistaken, and now, after more than a year, I do no longer feel inclined to underrate the magnitude of the new task which I have taken upon myself. My duties as an editor of the Bardic and Historical Survey of Rajputana were already very onerous, especially when I was labouring under the difficulty, not to say impossibility, of obtaining a competent assistant, and I now find that the new task has nearly duplicated them. The chief problem is how to find the time for everything. On one side the patient desk work of going through bardic manuscripts, preparing critical editions of bardic texts, compiling catalogues, examining and deciphering inscriptions, revising proofs, and attending to the official correspondence; on the other the hardships of long excursions under the most uncomfortable circumstances rendered still more uncomfortable by the necessity of making haste in order to save the most possible time, and the consequent task of writing reports on the places explored. The difficulties, as far as the exploration is concerned, have been greatly increased by the particular conditions prevailing in the Bikaner State, where the distances between one village and another are often enormous, and the camel is the only means of conveyance available. To cope with these difficulties, I have been forced to make all my tours *longis itineribus*, and I believe that by the rapidity of my camel marches I have established a record which no archaeological explorer will ever be able to beat. My enthusiasm for the work has, of course, always sustained me, but if I could be given more time to discharge all my different duties in less haste, it would certainly not be to the disadvantage of the work.

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[1] See "Progress Report, etc." for 1916, in *Journ. As. Soc. of Be.*, vol. xiii (N.S.), 1917, pp. 195-6.

EDITORIAL WORK.

The collection of the commemorative songs referring to the Rulers of Bikaner, which, as mentioned in the last "Progress Report,"[1] had been started under the title of *Vīkānera rī kavitā*, was enlarged during the year, and almost brought to completion. The work might have been sent to Press, but it has been detained in the hope that some new manuscript containing old songs might yet come to light in consequence of the search which is being made in the district.

The two poems on rāva JètaSī (*JètaSī rā Chanda*) also noticed in the last "Progress Report," have been examined and studied, and one of them, the shorter one which is, perhaps, the more valuable and the better preserved of the two and the name of whose author is known, has been selected for publication. In this case, too, the sending to Press of the poem has been deferred, to see if any other manuscript comes to light, in the meanwhile, to help to elucidate such passages as are not sufficiently clear in the two manuscripts that are so far available.

A new work which was taken into hand and also brought to completion, so far as the preparation for the Press is concerned, is the edition of the *Veli Krisana Rukamanī rī*, a Ḍiṅgaḷa poem composed by Rāṭhòṛa rāja Prithī Ṙāja of Bikaner in the year Saṃvat 1637 (1580-81 A.D.). Prithī Rāja was a younger brother of rājā Rāya Siṅgha, and a man who played a certain part at the Court of the great Akbar. He was a gallant chief and at the same time a poet of great ability, and his memory is much cherished in the Bikaneri tradition, where he is represented as a pious man gifted with a supernatural power of divination, and many anecdotes are related concerning him. As a poet, he occupies a very prominent place among the bards of the period, and is the author of many *gītas* on contemporary personages and events. The "Veli," mentioned above, is his great *chef d'œuvre*, and the enormous diffusion which this work had in Rajputana till about a century ago, is the best evidence of its excellence. That it is no longer popular to-day is simply due to the fact that the difficult language in which it is couched, is no longer understood by the average reader. The poem is, of course, in Diṅgaḷa, and though the subject—the story of the rape of Rukmiṇī by Kṛṣṇa and the sequel of their loves down to the birth of Pradyumna—is not bardic in itself, the treatment is bardic, the form is bardic, and the language is bardic. For my edition I have utilized eight manuscripts, mostly local, the oldest of which is dated in the year Saṃvat 1673, only thirty-six years after the composition of the work. The "Veli" has had several commentaries: the earliest, which probably goes back to the very time of the Author, is in Old Dhūḍhāṛī, or Old Eastern Rājasthānī; two others are in Old Māravāṛī, or Old Western Rājasthānī; and lastly there is one in Sanskrit composed by a *vācaka* Sāraṅga at Pālhaṇapura in the year Saṃvat 1678. Copious extracts from the various commentaries have been given in the Notes to the text, and it is hoped that they will be found of great help in understanding a work which is by no means of easy reading.

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[1] *Journ. As. Soc. of Be.*, vol. xiii (N.S.), 1917, pp. 195-252.

The cataloguing of the manuscripts found in the Bikaner State has been continued, and the compilation of fasciculus ii of Section i, Part ii of the *Descriptive Catalogue of Bardic and Historical Manuscripts*, has been taken in hand.

All the materials locally available for the *History of Bikaner* have been examined and collated, and I expect I shall be able to begin the compilation of the work soon after finishing my winter touring this year.

PUBLISHING.

Of the four publications which were in the Press at the end of 1916, namely: (1) the *Vacanikā Ratana Siṅghājī rī Mahesadāsòta rī*, (2) the fasciculus i of *Descriptive Catalogue of Bardic and Historical Manuscripts*, Section i: Prose Chronicles, Part i: Jodhpur State; (3) the fasciculus i of Ditto, Part ii: Bikaner State; and (4) the fasciculus i of *Descriptive Catalogue of Bardic and Historical Manuscripts*, Section ii: Bardic Poetry, Part i: Bikaner State, three were completely printed off during the year, but only one was issued before December 31st. This is the fasciculus of the *Descriptive Catalogue* dealing with manuscripts found in Jodhpur. As the Jodhpur Darbar refused to pay for this fasciculus, the Press bills had to be debited to the Bibliotheca Indica fund with the Asiatic Society of Bengal. The *Vacanikā* has been printed at the joint expense of the Darbars of Ratlam, Sitamau, and Sailana, three States which on account of their connection with Ratana Siṅgha, the hero of the poem, are especially interested in the publication. The two other fasciculi of the *Descriptive Catalogue*, dealing as they do with manuscripts found in Bikaner, are printed at the expense of the Bikaner Darbar.

Under the new arrangement, all the publications of the Survey are made by the Asiatic Society of Bengal in a special section of the Bibliotheca Indica. The cost of printing, etc., is charged to the particular Darbar concerned, and only in cases when the latter disclaim the obligation, is met from the Bibliotheca Indica fund. But there are good reasons for believing that the case of the Jodhpur Darbar will not be repeated, and the fact of the Darbars of Ratlam, Sitamau, and Sailana coming spontaneously forward to bear the cost of printing the *Vacanikā* merely from the idealistic motive of the connection of their families with Ratana Siṅgha, is a sign which clearly indicates that the Survey has kindled some interest in the Rajput States, in spite of any strange things that may happen in Jodhpur.

EXPLORATION.

As the full Report on the results of my touring will be published by the Archaeological Survey of India, in a separate volume, when completed, it will be sufficient for me here to give a brief notice only of such discoveries as directly interest the history of Rajputana in general and of Bikaner in particular. Out of the places personally explored by me during the year, the following were found to be archaeologically or historically interesting and have consequently been described in the full Report: (1) Sobhāsara (Jan. 11th), Bhākhala, Merāsara, Surāsara (Jan. 12th), Pūgaḷa (Jan. 13th-14th), Rāmasara (Jan. 15th), Bhavānīpurò, Jèmalasara (Jan. 16th), Kāhūnī (Jan. 17th); (2) Sujāṇagaḍha, Mā̃ḍetò (Jan. 21st), Gopāḷapurò (Jan. 22nd), Vīdāsara, Cāṛavāsa (Jan. 23rd), Chāpara (Jan. 24th); (3) Pūrabadesara (March 4th), Pallū, Kāḷāsara (March 4th-5th); (4) Bhaṭanèra or Hanumānagaḍha (March 25th-26th); (5) Sūratagaḍha (April 3rd, Dec. 28th-29th), Raṅgamahal (April 3rd), Māṇikatheṛī (April 4th), Vaḍopaḷa (April 4th, Dec. 29th), Kāḷī Vaṅgā̃ (April 4th-5th); (6) Ratanagaḍha (July 31st), Lādhāsara (August 1st), Khaṅgaṛa, Gaurīsara, Jāḷeū (August 2nd): (7) Ūdāsara (August 14th), Sardārsahar (August 15th); (8) Palhāṇò (Nov. 11th); (9) Vīkāsara, Roṛò, Kāvaḷīsara (Dec. 20th), Sārū̃ḍò (Dec. 22nd), Bhādalò, Pā̃cū (Dec. 23rd), Kūḍasū (Dec. 24th).

In spite of the fact that Bikaner is perhaps the poorest

State in Rajputana in respect to archaeological monuments, and this chiefly on account of scarcity of stone, the results of the exploration have so far been encouraging and remunerative. The most important discovery was made in the northern part of the State where, along the dry bed of the Ghagghar, a very interesting archaeological field was traced and Buddhist relics were found referable to the period of the celebrated Gandhāra school. But this find falls within the sphere of archaeology proper, and I cannot deal with it here. With reference to the history of Rajputana and of Bikaner, the most noteworthy results of the exploration were obtained from the *devaḷīs*. The scarcity of stone seems to have never prevented the Rajputs in the country from erecting to the memory of their dead these lapidary monuments, which together with their inscriptions, were meant to last as long as the sun and the moon, and to acquaint all the ages to come with the name of the Chief who spilt his blood in battle and of his female folk who were burnt alive on his pyre. In Bikaner, *devaḷīs* are as common as in any other Rajput State. Historically, these monuments are very important because the inscriptions which are always engraved upon them, have preserved to us with the greatest possible accuracy the name of the Chiefs who ruled over the country and the dates of their death. Unfortunately, many of the oldest inscriptions, instead of lasting as long as the sun and the moon, have been completely cancelled by the secular action of the sand blown against them by the winds of the desert, and other important *devaḷīs* have been lost or utilized for building purposes, and therefore a great part of the information contained in the *devaḷī*-inscriptions is lost for us to-day.

Naturally, the oldest *devaḷīs* are also the most interesting. The period when the *devaḷī* monument was first introduced into use, in the Bikaner tract at least, may be approximately fixed, I think, at about the middle or the later half of the Saṃvat century 1100. It seems that before this date the function of the *devaḷī* was performed by the *govardhana*. At Bhādalò, a village about 45 miles south of Bikaner, close to the Jodhpur border, I discovered a group of *devaḷīs* belonging to the very earliest period, one among which was dated in the year Saṃvat 1191. The information supplied by the inscriptions on these *devaḷīs* is new and very interesting. They all refer to *Chīkaṇas*, a Rajput tribe now generally considered to be a subdivision of the Bhāṭīs, and contain sufficient evidence to show that between the later half of the Saṃvat century 1100 and the earlier half of the Saṃvat century 1200, a family of Chīkaṇas ruled over Bhādalò and the adjoining villages with the hereditary title of *rāṇās*.

Next to the above-mentioned find in importance comes the discovery of a group of Mohila *devaḷīs* at Chāpara, a village about 70 miles east south-east of Bikaner. These are dated in the earlier half of the Saṃvat century 1300. Chāpara was one of the two capitals of the Mohilas, a branch of the Cahuvāṇas or Cāhamānas, who with the hereditary title of *rāṇās* for at least two centuries held under their sway a very large tract of country in what is now the south-eastern part of the Bikaner State, till they were subjugated by the Rāṭhòras in the early decades of the Saṃvat century 1500. Their other capital was Droṇapura, a place only 6 miles away, near the modern Gopāḷapurò. The *devaḷīs* found at Chāpara have preserved to us two names and two dates of the Mohila *rāṇās*, which do not quite tally with the genealogical list furnished by Mūhaṇòta NèṇaSī, the only source of information for the history of the Mohilas that has been accessible to this day, viz. *rāṇò* Sahaṇa Pāḷa who died in the year Saṃvat 1311, and *rāṇò* Araṛakò (his son ?) who died in the year Saṃvat 1348. Another Mohila *devaḷī*, a century older, was found at Sardārsahar, about 43 miles north of Chāpara. Unfortunately, the inscription on this *devaḷī* is so effaced that only the date Saṃvat 1241 and the name Mohila Inda Pāḷa (probably the father of the deceased) is legible to-day, but all the same the record is important in that it gives an idea of the extent to which the Mohilas were spread over the country in those early days.

Another group of *devaḷīs* dated in the earlier half of the Saṃvat century 1300, was found at Kāvaḷīsara, a village about 36 miles south of Bikaner. Unfortunately, only one of the inscriptions engraved on these *devaḷīs* has been preserved in a legible form. This commemorates the death of Sā̃khalò Kamaḷa Sī, the founder of the village, which took place in the year Saṃvat 1328. Evidently, the whole group refers to Sā̃khalās, probably a lateral branch of the Sā̃khalā *rāṇās* who ruled over Jā̃gaḷū and Rāsīsara.[1]

Several important *devaḷīs* throwing light on the history of the earliest Rāṭhòra colonizers of the Jaṅgaḷa country, have been found in the southern part of the State. At Palhāṇò, 14 miles south of Bikaner, was discovered the *devaḷī* of Mā̃ḍaṇa Riṇamalòta, a paternal uncle of rāva Vīkò, dated in the year Saṃvat 1539. On the bank of the Dantolaṛò nāḍivò, near Sārū̃ḍò, a distance of about 52 miles to the south of Bikaner, was discovered the *devaḷī* of Maṇḍaḷò Riṇamalòta, another paternal uncle of rāva Vīkò, dated in the year Saṃvat 1562. At Pā̃cū, about 36 miles south of Bikaner, were discovered the *devaḷīs* of two sons of Ūdhò Riṇamalòta, a third paternal uncle of Vīkò, viz. Pañcāiṇa and Sā̃gò. Pañcāiṇa who, perhaps, was the founder of Pā̃cū, died in the year Saṃvat 1568, whereas Sā̃gò died in the year Saṃvat 1581. The above-mentioned inscriptions are very important not only in that they supply us with the correct dates of the particular Chiefs to whom they refer, but also in that they confirm the statement in the *Khyātas* that Mā̃ḍaṇa, Manḍaḷò, and Ūdhò were among those kinsmen who accompanied rāva Vīkò when he left Marwar to go to conquer the Jaṅgaḷa country.

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[1] *Cfr* "Progress Report, etc." for 1916, pp 202-8.

Others of the inscriptions found supply us with dates referring to the ruling family of Bikaner. Among these may be mentioned: the *devaḷī* of Pūraṇa Mala, a son of rāva JètaSī, which was found at Sīlavò, near Pā̃cū, and is dated Saṃvat 1634; the *devaḷī* of Rāma Siṅgha, a son of rāva Kalyāṇa Mala, which was found at Ūdāsara, near Sardārsahar, and is likewise dated in Saṃvat 1634; and an inscription commemorating the *satī*s of rājā Daḷapata Siṅgha, a son of rājā Rāya Siṅgha, which is dated in the year Saṃvat 1677. The last-mentioned inscription was found in the fort of Bhaṭanèra (Hanumānagaḍha), 144 miles north-east of Bikaner.

Several *devaḷī*s of the Vīdāvatas, the descendants of rāva Vīdò, the uterine brother of rāva Vīkò, were found near Chāpara, in that tract of the Mohila country which they held under their sway. The oldest of these is the *devaḷī* of Vīdò's son Udè Karaṇa, which gives for his death the year Saṃvat 1565. It was discovered at Gopāḷapurò Among the others are: the *devaḷī*s of Rāma Khetasīòta (Saṃvat 1625), and of Kumbhakaraṇa Gopāḷadāsòta (Saṃvat 1645), both of which were found at Cāṛavāsa; the *devaḷī* of Goinda Dāsa Kesodāsòta (Saṃvat 1667), which was found at Vīdāsara; and the *devaḷī* of Āsa Karaṇa Giradharadāsòtà (Saṃvat 1682), which was found at Chāpara.

As a result of the exploration, impressions of 192 inscriptions have been collected and examined during the year. The oldest among these is dated Saṃvat 1084, and was brought by my explorer Sītā Rāma from Nòhara, a small town about 120 miles north-east of Bikaner. It is in northern characters All the others are later, and in Devanāgarī. A copper-plate dated Saṃvat 1445 and referring to the rule of Māṇika Siṅgha (for Māṇika Rāva, one of the Mohila *rāṇā*s), was found with a brahmin at Chāpara, but on examination was ascertained to be a later forgery.

No Rajput paintings were found, and the search in this respect was a complete failure. A few were found, it is true, in the Bikaner town, but all recent and worthless. There seems to be very little hope of finding any paintings in the district.

Two or three good copies of the *Prithī Rāja Rāsò* were brought by me from Bhaṭanèra, and a few other Bardic manuscripts were borrowed from the Thakur of Nokhò and from the Cāraṇas of Vīkāsara and Manḍāḷa. These have been described in the *Descriptive Catalogue*. A total of 14 manuscripts was purchased during the year, all from places outside the Bikaner State. The number of the manuscripts received was 3. and that of the manuscripts copied 9. A list of the manuscripts received (*R*), purchased (*P*), and copied (*C*), is given below.

MANUSCRIPTS RECEIVED.

R. 19 : वीसलदे चौहाण कौ रास कवि नाल्ह कृत .

Size 4⅛″ × 10″. No. of leaves 15. Loose. Jaina.
Written in Saṃvat 1775 at Mālarapura.
Presented by the Jainācārya Dharma Vijaya Sūri, March 1917.

R. 20 : पदमणी चउपई लब्धोदय कृत .

Size 4¾″ × 9¾″. No. of leaves 28. Loose. Jaina.
About 100 years old.
Presented by the Jainācārya Dharma Vijaya Sūri, April 1917.

R. 21 : फुटकर कविता .

Size 8″ × 6″. No. of leaves 43. Fragmentary. Stitched, but uncovered.
About 70-100 years old.
Presented by Bāraṭha Deva Karaṇa of Mathāṇiyā, October 1917.

MANUSCRIPTS PURCHASED.

P. 23 : षीरमाण ढाढो बहादर री कहो,
फुटकर गीत दूहा .

Size 13″ × 8¾″. No. of leaves 32. Cloth-bound.
Copied at Nokhò by Sā̃dū Siva Karaṇa. About 100 years old.
Purchased in October, 1917.[1]

P. 24 : हरिप्रकार (?) टीका हरिचरणादस कृत (incomplete),
महाराजा तखतसिङ्घजी रा दूहा ५३ साँदू भोपाल़दान रा कहिया,
विहारी सतसई रा दूहा कुटकर,
रामचरित्र कवितबन्ध तुलसीदास कृत (incomplete),
गीत कुटकर साँदू भोपाल़दान रा कहिया .

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[1] For delicate reasons, which I need not specify further, I am obliged to discontinue the publication of any particulars concerning the place where manuscripts are purchased.

Size 13″ × 8″. No. of leaves 58. Fragmentary. Bound, but uncovered. About 100 years old, at the most.
Purchased in October, 1917.

P. 25 : जोधपुर री ख्यात राजा गजसिङ्घजी तथा जसवन्तसिङ्घजी रै बखत री (incomplete),

राजा गजसिङ्घजी रा गुणझूलणा बारठ राजसिङ्घ प्रतापमलौत रा कहिया (incomplete).

Size 12½″ × 8¾″. No. of leaves 30 (१९३-२२२). Loose. Incomplete at the beginning owing to the loss of the first 192 leaves. About 200 years old.
Purchased in October, 1917.

P. 26 : पाबूजी रा दूहा मूहता लधराज रा कहिया,

पाबूजी रा छन्द वीठू मेहै रा कहिया,

हालाँ झालाँ रा कुण्डलिया (incomplete).

मानजय(?)मण्डण अथवा महाराजा मानसिङ्घजी रौ गुण दूहाबन्ध आसिया वाँकीदास रौ कहियौ .

Size 17″ × 8″. No. of leaves 37, of which a few blank. Loose. Written about Saṃvat 1905.
Purchased in October, 1917.

P. 27 : सूरछत्तीसी,

कायरबावनी,

विदरबत्तीसी,

वेसकुवारता (incomplete),

फुटकर .

Size 9″ × 6″. No. of leaves 28. Loose. Fragmentary. About 100 years old.
Purchased in October, 1917.

P. 28 : आउवै धरणौ ऊवौ तै रा कवित्त २५,

पाण्डवयशेन्दुचन्द्रिका (fragment of the end only).

Size 10″ × 6½″. No. of leaves 10. Loose. Fragmentary. Written in Saṃvat 1939.
Purchased in October, 1917.

P. 29 : हरिरस ईसरदास कृत (fragmentary),
नागदमण .

Size 6″ × 9″. No. of leaves 20. Loose. Fragmentary. Written at Pādarū by Paṇḍit Lāla Canda in Saṃvat 1855.

Purchased in October, 1917.

P. 30 : फुटकर कवित्त गीत दूहा .

Size 6¾″ × 4¾″. No. of leaves 14. Bound, but uncovered. Fragmentary. About 50-100 years old.

Purchased in October, 1917.

P. 31 : गुणरामरासौ धधवाड़िया माधवदास रौ कहियौ .

Size 5½″ × 7″. No. of leaves 43. Loose. Fragmentary. Bad and incorrect writing. Copied by Khiṛiyò (?) Rāma Canda at Cāraṇavāsaṇī in Saṃvat 1798.

Purchased in October, 1917..

P. 32 : राठौड़ सिवसिङ्घजी आउवै रौ रूपक लाल़स नवल़ रौ कहियौ .
फुटकर .

Size 4″ × 6½″. No. of leaves 41. Cloth-bound, but with several leaves detached. Fragmentary. About 100 years old.

Purchased in October, 1917.

P. 33 : परमेसर रै स्तुति रा गीत दूहा,
अवसुराँ री विगत,
राठौड़ाँ री पीढियाँ री कविता .

Size 6″ × 9½″. No. of leaves 28. Bound, but uncovered. Fragmentary. About 70-100 years old.

Purchased in October, 1917.

P. 34 : गुणरामरासौ धधवाड़िया माधवदास रौ कहियौ .
हररस बारठ ईसर रौ कहियौ .

Size 6⅛″ × 9″. No. of leaves 103. Bound, but with some leaves detached at the beginning and at the end. Copied in Saṃvat 1798, partly by Mathena Bakhatò and partly by Sevaga Vasatò.

Purchased in October, 1917.

P. 35 : नागदमण,

थोरियाँ री वंसावल़ी रा छन्द,

माताजी रा छन्द,

फुटकर .

Size 8½″ × 6″. No. of leaves 78. Originally leather-bound, now without cover and with all the leaves damaged by water, which has caused the ink to fade. Written between Saṃvat 1729 and 1733 by some Cāraṇa.

Purchased in October, 1917.

P. 36 : ऊदावत रूपसिङ्घजी री झमाल़ आसिया वाँकीदास री कही,

हालाँ झालाँ री वारता,

हालाँ झालाँ रा कुण्डल़िया,

राजा इन्द्रसिङ्घजी री झमाल़ साँदू सबल़सिङ्घ री कही,

महाराजा अभैसिङ्घजी रा कवित्त खिड़िया बखता रा कहिया,

फुटकर गीत .

Size 11″ × 7½″. No. of leaves 190. Complete, but for two or three leaves missing at the beginning and at the end. Leather-bound. Written about Saṃvat 1900.

Purchased in October, 1917.

MANUSCRIPTS COPIED.

C. 98 : राजा सूरसिङ्घजी रौ पाघड़ी छन्द, 14 leaves.
From MS. No. 25 of *Descr. Cat.*, Sect. ii, pt. i (pp. 39*a*-49*b*).

C. 99 : राजा सूरसिङ्घजी री वेलि गाडण चोल़ै री कही, 4 leaves.
From MS. No. 21 of *Descr. Cat.*, Sect. ii, pt. i (pp. 2*a*-3*a*).

C. 100 : राणै हमीर रिणथम्भोर रै रा कवित्त, 6 leaves.
From the same MS. (pp. 171*b*-173*a*).

C. 101 : खीची गाँगेव नीँबावत रौ दोपौहरौ, 31 leaves.
From MS. No. 22 of *Descr. Cat.*, Sect. i, pt. ii (xlv, pp. 408*b*-416*b*).

C. 102: भाटियाँ री ख्यात, 109 leaves.

From MS. No. 27 of *Descr. Cat.*, Sect. i, pt. ii (*c*, pp. 31*a*-99*a*).

C. 103: ऊमादे भाटियाणी री वात, 5 leaves.

From MS. No. 22 of *Descr. Cat.*, Sect. i, pt. ii (xxiv, pp. 358*b*-359*b*).

C. 104: राव चूँडै री वात, 9 leaves.

From MS. No. 28 of *Descr. Cat.*, Sect. i, pt. ii (*a*).

C. 105: राव अमरसिङ्घजी रा दूहा बारठ नरहरदास रा कहिया, 49 leaves.

From the same MS. as *C.* 91 (pp 118*b*-152*b*).

C. 106: तेजसी डूँगरसीओत रा कवित्त नेतसी सीलगा रा कहिया, 9 leaves.

From the same MS. (pp. 284-89).

APPENDIX I.

RAJASTHANI CHRONICLES.

Last year in appendix to my "Progress Report" I gave a few specimens of bardic poetry, and I propose to do the same this year with regard to the prose chronicles, the other of the two great sections in which the bardic and historical literature of Rajputana is divided. The subject is new and very important. Though Col. J. Tod first in his "Annals and Antiquities of Rajasthan" and Mr. A. K. Forbes afterwards in his "Rās Mālā" have made accessible to the public, in a popular form, a considerable part of what forms the subject of this chronical literature, yet the two books above-mentioned are hardly calculated to convey an accurate idea of what a Rajput chronicle is. The fact is that both Col. Tod and Mr. Forbes were seeing the historical and literary documents in their hands not in the light of documents, but merely in the light of mines of information; they confined themselves to exploiting the contents of the works, and did not pay any attention to the questions of form, age, authorship, attendibility, etc. of the works themselves. In other words, they completely ignored the critical examination of their sources, and when they exercised a criticism at all, this was a criticism of the events they were dealing with, not of the sources from which they were deriving their information. In this sense it may be said that the subject is still new, for although we know a considerable portion of the contents of the chronicles of Rajputana, we do not know exactly on which lines these chronicles are composed, nor do we know anything about the origins, the growth, and the historical value of this interesting literature, which has been so far only vaguely and gropingly referred to as the "Bardic Chronicles."

The term "Bardic Chronicles" itself is vague and inaccurate. It was first introduced by Col. Tod, and not without reason, for Col. Tod relied for his information chiefly on historical poems, such as the *Khumāṇa Rāsò*, the *Sūraja Prakāsa*, etc., and these historical poems, which he considered not in the light of literary works but merely in the light of historical sources, could from his particular point of view be described as "Bardic Chronicles." The real chronicles apparently remained unknown to Tod, except for a few genealogical works and biographies, to which he explicitly alludes, or, if he was aware of their existence, he did not take them into proper account, probably because he found that the historical poems gave him a better inspiration for that apotheosis of the Rajputs which he meant to compile. The preference given by Tod to the historical poems or, as he calls them, "Bardic Chronicles," against the real chronicles, has naturally resulted in keeping the latter in obscurity, and in spreading the erroneous idea that the vernacular chronicles of Rajputana are chiefly poetical works in which the plain facts are mixed up with legends, altered by love of party, and distorted by poetical exaggerations. Now if the defects which I have just enumerated are constantly found in the historical poems, they are not found in the real chronicles in prose, which in the best examples leave nothing to desire in respect to accuracy, soberness, and even impartiality. The existence of such chronicles has been unknown to this day, and therefore the pleasant task of introducing them to the world is to me a matter of special satisfaction.

In my "Descriptive Catalogue" I have divided the bardic and historical literature of Rajputana into two great sections: (*a*) Bardic Poetry, and (*b*) Prose Chronicles. The historical poems alluded to above, together with the commemorative songs (*sākha rī kavitā*), and other poetical compositions directly or indirectly connected with the history of Rajputana, fall within the former section. It is, almost exclusively, the production of the bards of the Rajputs; Cāraṇas, Bhāṭas, Ḍhāḍhīs, etc., but especially Cāraṇas. Under the other section of *Prose Chronicles* I have included all works in prose of an historical or semi-historical character, such as chronicles proper, genealogies, biographies, legendary accounts, historical tales and romances, etc. A peculiar feature of the works under this section, as contrasted with the bardic works, is that, with a very few exceptions, they are adespotic and a very large proportion of them are not the production of bards. From this it may be seen how incorrect the term "Bardic Chronicles" is, both when applied to the bardic poems and when applied to the chronicles proper. A correct term for the latter is "Rajasthani Chronicles," which is wide enough to include all the chronicles of Rajputana; "Rajput Chronicles" would be a more generical term which might include also the chronicles of the Rajput States of Gujarat if there are any such works in existence; whereas "Marwari Chronicles" would be a narrow term comprehending, in a strict sense, only the chronicles written in Marwari, the principal vernacular of Rajputana. Each of the three terms suggested above has its own advantages, which may make it seem preferable to the others in particular cases; but as a generical term for all cases "Rajasthani Chronicles" is the most suitable one.

Leaving out of consideration the historical tales and romances—locally known as *vātas*—, which are generally the work of bards and only because they are written in prose fall within the category of Prose Chronicles; and also the biographies and the brief accounts of particular facts—likewise known as *vātas*—which, though often accurate and important, are too disparate from one another in form, character, subject, and length, and too numerous to be easily reduced to a type; I shall confine myself to giving an idea, in these pages, of the two compositions which are the most important historically, namely: the chronicles proper and the genealogies. The former are generally known in Rajputana under the name of *Khyāta* f., a word etymologically connected with the Sanskrit *khyāti* f. "fame, renown," or possibly *ākhyāti* f. "narrative."[1] They may vary considerably in length, form, and accuracy, but a feature common to all the *khyātas* is that they relate the history or the chief events in the history of a Rajput State in chronological order, reign after reign, always keeping the rulers in prominent view. The genealogical works are locally known as *pīḍhiyā̃*, meaning "generations," also *pīḍhiyāvaḷī* "series of generations," and, more rarely, *piriyāvaḷī* "line of ancestors." They are, generally, in the form of lists of bare names—without dates—in which the names are given in a descending order, generation for generation, first the main line and then the lateral branches. They are often voluminous works, and almost invariably reliable for the accuracy of their information.

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[1] In Ḍiṅgaḷa poetry one often meets the word *akhiyāta*, which is used in the sense of "wonder, marvellous feat, renown, etc." (cfr. *Veli Krisana Rukamaṇī rī*, 133, where it is rendered with: "khyātir āšcaryam . . . . stutiyogyā vārttā ce'ti" by the Sanskrit commentator). From a passage in the *JètaSī rò Chanda* by Vīṭhū Sūjò (st. 192), it appears that the word is an adjective meaning "wonderful, extraordinary," probably from Sanskrit *a-khyāta* "untold," hence "unheard of, extraordinary, marvellous." But I am very doubtful as to whether this poetical adjective *akhiyāta* can be the prototype of the common word *khyāta*; it seems much easier to connect the latter with a well-known term such as the Sanskrit *khyāti*, or *ākhyāti*.

Of the two compositions, the genealogies are undoubtedly the older. The custom of keeping genealogical records of the kings is at least as ancient as the Purāṇas, and that this custom was still in vogue at the time of the rise of the Rajput power in Western India is proved by the existence of numerous *praśasti*-inscriptions, dated in that period. But the genealogies which were in existence in the early times of the Rajput period, whether preserved orally or graphically, must have been a very modest thing, probably containing only the names of the Chiefs who inherited political power and in no case going beyond the Chief who was the first to conquer the land and to emerge from obscurity. Thus the Udepur *praśasti* of the Paramāras of Malwa begins from Upendra, who "by his bravery gained the honour of exalted kinghood"[1]; the Jodhpur *praśasti* of the Pratihāras of Mandora begins from the four brothers Bhoga Bhaṭa, Kakka, Rajjila, and Dadda, who "possessed themselves of and fortified Māṇḍavyapura"[2]; and the Abu *praśasti* of the Guhilòtas of Mewar begins from Bappa, who "had royalty conferred on him by the sage Hārīta."[3] The fact that most of these *praśastis* were composed by brahmin poets, who called themselves *bhaṭṭas*,[4] is not without significance. Though the term *bhaṭṭa* may occur as a mere honorific title for learned brahmins in Sanskrit, it is clear that in the *praśasti*-inscriptions it is used in a particular sense, *i.e.* in the sense of "bard, or genealogist." The genealogists of Rajputana, and not of Rajputana alone, even to this day are known under the name of "Bhāṭas," a word which evidently is but the vernacular form of *bhaṭṭa* From the identity of the denomination it does not necessarily follow that all the Bhāṭas are of brahmin extraction, but what we can safely conclude is that the Rajputs of the early period had in their stipend genealogists, called *bhaṭṭas* or *bhāṭas*, and these were brahmins of learning who used to compose in Sanskrit poetical panegyrics in honour of their patrons and their patrons' ancestors. Whether these *bhaṭṭas* who composed the *praśastis* kept regular genealogical records or not it is difficult to say, but from the fact that different *praśastis* of the same dynasty do not always completely agree in the names given, it would seem that, in some cases at least, there were no regular records, and

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[1] *Ep. Ind.*, vol. i, pp. 222 ff.

[2] *J.R.A.S.*, 1894, pp. 1-9.

[3] *I.A.*, vol. xvi, 1887, pp. 345-355.

[4] The Citor inscription of rāṇò Mokala of Mewar (*Ep. Ind.*, ii, pp. 410 ff.) shows that even as late as the beginning of the fifteenth century A.D. *praśasti*-inscriptions were composed by *bhaṭṭas*.

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that the only written genealogies were the *praśasti*-inscriptions themselves. Certainly, till at least the beginning of the fourteenth century A.D., when the Old Bhāṣā period may be considered to begin, there were no chronicles nor any other historical records in existence, except sporadic epical poems in Sanskrit like the *Vikramāṅkacarita*, the *Pṛthvīrājavijaya*, etc. That there were no historical records in existence is shown even by the *praśasti*-inscriptions, which very often give a merely conventional description of the forefathers of a king, without mentioning a single historical exploit in connection with them. Evidently, in such cases, all the particulars concerning the life of the persons in question had been forgotten, except their names.

The coming into existence of a Bhāṣā literature towards the fourteenth century A.D. and the gradual substitution of Bhāṣā to Sanskrit in versification and ordinary writing, must have had the immediate effect of popularizing a pursuit which before had been the prerogative of a few learned brahmins. Cāraṇas and other poets in the vernacular appeared on the scene and their spirited panegyrical songs, which had the advantage of being understood and appreciated by everybody, gained a definite victory over the panegyrical poems in Sanskrit, which had never been very popular. The *bhaṭṭa*s of the *praśasti*s gradually forgot their Sanskrit and took to compose in Bhāṣā, and the genealogical records which were formerly incised on stone, were thenceforth committed to paper.[1] The precise time when pedigrees began to be put into writing is, of course, difficult if not impossible to determine, but in the case of the Rāṭhòṛas it is certain that written genealogies of some kind were in existence at the time of rāva Riṇa Mala—earlier half of the fifteenth century A.D.—if not before. This is shown by the fact that the *pīḍhīyāvaḷīs* we possess of the Rāṭhòṛas leave something to desire, in regard to fullness and accuracy, in the period going from Sīhò to rāva Cũḍò—Riṇa Mala's father—, whereas they are full and accurate from the time of Cũḍò downwards.[2] These first genealogical records probably

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[1] Pedigrees, of course, were also preserved by memory. Even to this day Rajputs and Jats in the desert know their pedigrees by heart. At Sirdargadh, west of Suratgadh, I was surprised to find rude Johiyās reciting to me their pedigrees in harsh Rāṭhī from the name of their father back to a mythical Johiyò believed to be the progenitor of the race. Their parrot-like recitation began :—लालखाँ लक्खै दा लक्खा गम्भी दा गम्भी राणै दा राणा सुरब्बू दा-सुरब्बू ततार दा...etc.

[2] The position of the above names in the succession of the early Rāṭhòṛa Rāvas, may be seen from the list which I give below: 1. Sīhò > 2. Āsathāna > 3. Dhūhaṛa > 4. Rāya Pāla > 5. Kanha Rāva > 6. Jālhaṇa > 7. Chāḍò > 8. Tīḍò > 9. Salakhò > 10. Vīrama > 11. Cũḍò > 12. Riṇa Mala > 13. Jodhò > 14. Vīkò.

पुस्तकालय
गुरुकुल कांगड़ी, हरिद्वार

consisted of bare lists of names, and a particular feature in them was that they did not begin from Sīhò—the founder of the Marwar branch of the Rāṭhòṛas—, but from Saḷakhò, the eighth in descent from Sīhò, and in some cases even from Cū̃ḍò, a grandson of Saḷakhò. Thus a *vaṃśāvalī* contained in a manuscript from Phaḷodhī, dating from the end of the sixteenth century A.D., begins from Saḷakhò and ignores all the period preceding him. The adespotic *JètaSī rò Chanda,*[1] composed about half a century earlier, also begins from Saḷakhò and never mentions any of Saḷakhò's predecessors. Evidently, at the time when regular genealogies of all the branches of the family began to be compiled, Saḷakhò was the earliest ancestor about whom written or oral evidence was abundant or at least sufficient, whereas the memory of Saḷakhò's predecessors had already begun to fade. In this connection it is worth mentioning that one of the eponyms of the Rāṭhòṛas is *Saḷakhās*, meaning "the descendants of Saḷakhò."

Now Saḷakhò lived towards the middle of the fourteenth century A.D. The *pīḍhiyāvaḷī* contained in MS. 19 of *Descriptive Catalogue of Bardic and Historical Manuscripts*, section i, part i,[2] begins from Cū̃ḍò, two generations after Saḷakhò. This work was compiled towards the middle of the seventeenth century A.D., but it is evident that it must be based on an older *pīḍhiyāvaḷī* which gave the genealogies of the Rāṭhòṛas from the time of Cū̃ḍò. I have said above that the earlier *pīḍhiyāvaḷīs* consisted of bare lists of names, without dates or other particulars This is borne out by the fact that the later *pīḍhiyāvaḷīs*, which as we shall presently see, were compiled from the former, give occasional dates for the period Saṃvat 1500 downwards, but hardly give a single date for the period Saṃvat 1500 upwards.[3] What the system of classification in the earlier *pīḍhiyāvaḷīs* was, I am not able to say, but it probably was an imperfect one, and the works were more in the form of a collection of disconnected lists than in the form of orderly treatises.

The later *pīḍhiyāvaḷīs*, which came into existence towards the end of the sixteenth century A.D. and which are, intrinsically, the same as those which we now possess, are in the form of orderly treatises. They were compiled, of course, from the earlier works, but on a well arranged plan, and were integrated with the addition of all the genealogies intervening between Sīhò and Saḷakhò, which had been left out of account in the earlier works. Not only this, but they were also enlivened by the insertion of short biographical notes on the most distinguished names, such as a mention of the village or villages which the individual in question held, the battles in which he fought, the place where he died, etc., and dates were often quoted in connection with these events The system adopted for classifying the thousands of names in the different branches which trace their origin to Sīhò, is a very simple and at the same time a very convenient one. Each generation, starting from Sīhò who represents the first generation, is marked by a progressive number both in the main line and in the lateral lines, and this number is prefixed to each name in the different lists, so that it is possible to know at once to which generation a particular individual belongs. The first to be treated is, naturally, the main line; then successively the lateral lines in a chronological or descending order, *i.e.* according to the degree of seniority of each line. In some cases, however, the lateral lines were given in an ascending order, *i.e.* instead of describing first the offshoots of the second generation, then those of the third, and so on, the offshoots of, say, the nineteenth generation were described first, then those of the eighteenth, then those of the seventeenth and so on, in an inverted order. This irrational arrangement was, I believe, introduced with the object of bringing into greater prominence the lines and the individuals more closely related to the sovereign ruling at the time, and there can be no doubt that the original arrangement was according to the chronological or descending order, but that the ascending system was introduced pretty early is shown by a Jodhpur *pīḍhiyāvaḷī* of the time of mahārājā Jasavanta Siṅgha I (later half of the seventeenth century A.D.), in which it is adopted.[1]

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[1] *Descr. Cat. of Bard. and Histl. MSS.*, section ii, pt. i, pp. 7-8.

[2] Pp. 63-66.

[3] Here Saṃvat 1500 is given as a round figure. As a matter of fact a few dates falling within the later half of the Saṃvat century 1400 are found in the later *pīḍhiyāvaḷīs*.

By whom were the *pīḍhiyāvaḷī*s compiled ? From the fact that the *praśasti*s of the early Rajput period were composed by *bhaṭṭa*s and that the modern genealogists of Rajputana are still known under the name of "Bhāṭa," which is the same word, it would seem, from the evidence of this name, that the profession of a *bhaṭṭa* or *bhāṭa* has continued uninterruptedly from those early times to the present day, and consequently the Bhāṭas ought to be the authors of the *pīḍhiyāvaḷī*s. But if we compare the rough, disconnected, unintelligible genealogical lists kept by the Bhāṭas to-day with the orderly and accurate *pīḍhiyāvaḷī*s of three centuries ago, we can scarcely believe that these could have been made by their ancestors. Anyhow, it is certain that, as far as the Rāṭhòras are concerned, they had also one or more Jain Jatīs who kept regular records of the family, and these Jatīs are possibly entitled to some credit for the compilation of the *pīḍhiyāvaḷī*s. Another thing, which seems equally certain, is that the *pīḍhiyāvaḷī*s we know so far, have all been compiled under the aegis of the sovereign Chief by men in his employment or in his train. Works like these cannot be explained as being merely the outcome of private initiative, it is clear that they must have grown under the encouragement of the Chief. Possibly, while ordinary Bhāṭas were going about begging village for village and door for door with their genealogical scribbles as they do to-day, other men better trained in methodical and accurate work were compiling the *pīḍhiyāvalīs* in the capital, probably in part from the very data furnished to them by the travelling Bhāṭas. It is not unreasonable to suppose that these compilers of the *pīḍhiyāvalīs* were the same men who compiled the chronicles, and brought the same accuracy and methodicity to bear on both the works. Certainly, accuracy and methodicity are not qualities to be found in a Bhāṭa, who much like the Cāraṇa, has an unbalanced judgment ruled by fits of passion and a manner of expression deformed by an irresistible tendency towards hyperbole and fiction. Bhāṭas were poets from the earliest times to at least three centuries ago, and now that they are no longer poets, are nothing more than ignorant charlatans, often even more ignorant than the simple people they dupe. Now, poets can hardly be believed to have been the compilers of the *pīḍhiyāvalīs*. The Bhāṭas were the repositories of genealogical lore from the earliest times, no doubt, but no Bhāṭa probably ever possessed the ability of embodying the loose and unshaped materials in his possession into an organic work, and if he ever tried to give a literary and finished shape to these materials, it was the shape of poetry. There are numbers of genealogical verses—i.e. verses containing pedigrees—in existence, and these might well be the production of the Bhāṭas of some centuries ago [1]

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[1] *Descr. Cat. of Bard. and Histl.* MSS., sect. i, pt. i, MS. 18, pp. 59-63.

Internal and external evidences combine to show that the chronicles proper, or, as they are locally called, the *khyātas*, must have come into existence contemporaneously with the *pīḍhiyāvaḷīs*, *i.e.* towards the end of the sixteenth century A.D. This is not a mere coincidence, and I believe that both the above-mentioned compositions have sprung from the same seed under identical circumstances. That there were no prose records of any kind in existence before the end of the sixteenth century A.D., I will not say; perhaps there were, but if so, they were even more imperfect and disconnected than the genealogical lists of the early period. Certainly, so far as Jodhpur and Bikaner are concerned, connected histories and chronicles seem to have been unknown until the time mentioned above. How could they originate, then, all of a sudden, towards the end of the sixteenth century A.D.? The explanation is very simple if one only thinks of the political circumstances in which the two principalities of Jodhpur and Bikaner—to say nothing of others—found themselves about that time. Before the middle of the sixteenth century A.D. both Jodhpur and Bikaner had fallen within the sphere of power of Šer Šāh, and a few years afterwards the Princes of the two rival States met each other at the Court of the great Akbar. It is natural that there, before an Emperor who was ever ready to lend an interested and benevolent ear to the stories, beliefs, and disputes of his subjects, the Princes of Rajputana brought all their mutual rivalries and their controversies about pre-eminence and seniority, and each tried to back his claims with pedigrees of his family and with such stories as tended to add prestige to it. In doing so, they served a double purpose: asserting their right to a conspicuous position among their fellow Princes, and commanding more consideration from the Emperor. It was thus a spirit of emulation and ambition that awoke in the Rajput Princes who gathered at the Imperial Court, an interest in historical matters. Such an interest never existed before, when the Princes, living within the ramparts of their cities, were satisfied with the panegyrics of their bards and the flatteries of their parasites, and never seemed to care much about their remote ancestors nor to inquire whence they came from. But now they began to inquire into the origins of their family, to refresh the memory of their ancestors and the traditions concerning them, and to complete their pedigrees with long lines of *paurāṇika* names linking their progenitors with Rāmacandra, Kṛṣṇa and other illustrious personages of world-wide

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[1] These genealogical verses are usually in the form of *kavittas*. They are of two kinds: dynastic and genealogical. The former record the names of a series of rulers who succeeded one another, and sometimes also give the number of years of their respective reigns. The latter more commonly record the names of the sons of a particular Chief, as the *kavitta* following which contains the names of the twelve sons of rāva Cūḍò:

रिणमल रावाँ राउ
    सतौ हरचन्द पटन्तर।
राउत गुर रिणधीर
    भुजाँ बळि भीम भीम सर।
कान्हौ अरड़कमाल
    पौहव पुनौ अरिगञ्जण।
सहिसमाल नै विजौ
    लाख दळ लूँभौ भञ्जण।

सिवराज रामदे गोप कहि
वीरत दान समङ्गला ।
बारै नरिन्द चूंडै तणा
खेक खेक हूं खमाला ॥ १ ॥

fame. It was at this time that the Guhilòtas advanced a claim to be the descendants of Noshirwan,[1] and the Rāṭhòṛas connected their origins with the Gahiravāḷas of Kanauj. It was again at this time that rājā Rāya Siṅgha caused a long *praśasti*-inscription to be engraved in the new fort of Bikaner, tracing his descent to Sīhò, and hence to rājā Jayacandra of Kanauj, and hence to Rāmacandra, and hence to the Sun-god himself. And it was at this very same time that regular *pīḍhiyāvaḷīs* and *khyātas* came into existence. There is no mistaking the meaning of this coincidence.[2]

Thus the impulse came from that spirit of emulation which, though long pre-existent, was intensified and fostered at the Court of Akbar. And the Rajput Chiefs summoned their bards and genealogists and caused them to compile historical sketches of their families, in the plain language of prose. These were the *vaṁśāvalīs*. Being composed by bards or, at least, from the information in the hands of the bards and from the traditions preserved by them, these historical sketches are far from accurate and reliable, but are not the less important as embodying in themselves much of what was known or believed at the time concerning the earlier period. That they were chiefly composed by bards and from bardic sources, is shown not only by the defective arrangement, the disproportion of parts, and the prominence given to legends and anecdotes, but also by the occasional quotations of bardic verses and songs and the fact that these quotations are given as documentary evidence in testimony of the truth of the narrative itself (*sākha rī kavitā*). The first *vaṁśāvalīs* were works of small proportions and humble pretensions, but soon enough they were taken up by other hands—the compilers of the *khyātas*—who reorganized them, completed them by filling up all their lacunæ as far as it was possible, and incorporated them into the *khyātas*, which had meanwhile come into existence, so as to convert the latter into complete chronicles of the dynasty from the origins to the current day.

The first *khyātas* were chronicles of contemporary events. In contrast with the *vaṁśāvalīs*, which later got incorporated into them much to their discredit, the first *khyātas* were remarkable for accuracy, sobriety, and dispassionateness. They contained no legends, no quotations of bardic verses, no flatteries, no lies, but merely plain statements of facts teeming with names and dates, these facts contemporary and many of them witnessed by the writer with his own eyes. They could not be the production of bards, and if there were a shade of doubt about it, the mere consideration that they do not contain bardic verses nor place the bards in prominence, is sufficient to dispel it. A bard never keeps himself in the background. By whom were they compiled then ? Abul Fazl in several places in his work speaks in enthusiastic terms of the keen interest which Akbar took in matters historical, and in the xxii chapter in his second volume explicitly tells us that in the nineteenth year of his reign (1574 A.D.) Akbar established a Record Office. The example of the Emperor must have been contagious for the Rajput Princes, who for the particular reasons pointed out above were at that time equally interested in historical pursuits. Perhaps the Emperor himself suggested to them that they should also keep records of all the notable events happening in their respective territories and of the campaigns which they were making in the service of the Empire, and they readily responded to the hint. Maybe Akbar wanted these provincial records to supplement the records in the central office, or he wanted to have them read before his presence, a supposition not altogether unlikely in the case of a monarch who caused the *Rājataraṅginī* to be translated on the occasion of his first visit to Kasmir.[1] Anyhow, the Rajput Princes kept their own records and in a manner which more than anything gives credit to the view that they were inspired by Akbar. The compilers can hardly have been anybody else but the Princes' officials themselves, the Pañcolīs and the Mahājanas, collectively known as *mutsaddīs*, who from those times to the present day have been filling all the most important posts in the establishments of the Rajput States. These were the only people who were able to write correctly and currently; the bards having never had a reputation for orthographical and intelligible writing. Besides, they were the only people who could view facts in their natural light, grasp their meaning, and write an accurate and luminous account of them. They were people trained to business transactions, desk drudgery, and office routine, and consequently were well qualified for a work which is essentially a work of methodical and patient accuracy. And they acquitted themselves of their task admirably.

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[1] Tod, i, pp. 189-195 (Routledge's edition); Jarrett's *Āīni Akbarī*, ii, p. 268.

[2] The explanation here given of the origin of the Rajasthani Chronicles, applies in particular to the case of Jodhpur and Bikaner—the only Rajput States whose bardic and historical literature I have been able to explore to an appreciable extent, so far. But it is reasonable to assume that the same explanation in the main is applicable also to the other States of Rajputana which likewise possess a bardic and historical literature.

Unfortunately, of these contemporary chronicles which the above-mentioned officials of the Rajput Princes began to compile at the time of Akbar and continued compiling down to about a century ago, very few are available to-day. This is in part due to the apathy of the later Rulers, who instead of seeing that these precious records were safely treasured in the

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[1] Jarrett's *Āini Akbarī*, ii, p. 380.

State archives, allowed them to remain with the families of their compilers, the *mutsaddīs*, with the result that they are completely lost to the State to-day. That there are still several *vahīs* containing *khyātas* in the houses of the descendants of the old *mutsaddīs* of Jodhpur and Bikaner, is known to everybody, but these *vahīs* are so jealously concealed that even the respective Darbars are unable to induce their owners to produce them. Thus the blind ignorance and irresponsible wickedness of the owners has kept hidden from sight most valuable materials which, if known, would throw much light on the history of the States concerned and of India as well.

I have said that shortly after coming into existence, the contemporary records—which, naturally, were in the form of notes not necessarily connected with one another—were incorporated with the materials of the *vaṃśāvalīs* and, I may add here, of the genealogies, into a unique and in external appearance homogeneous composition, also called *khyāta*, but extending from the origins of the ruling family, not to say of the world itself, down to the current times. This happened as early as the middle of the seventeenth century A.D., and the most noteworthy examples of these compositions were produced in Jodhpur under the enlightened rule of mahārājā Jasavanta Siṅgha I, and his prime minister Mūhaṇòta Nèṇasī. The latter, who was especially keen on subjects of historical research, is well known in Rajputana and particularly in Jodhpur and Bikaner for a work of general history of the Rajput tribes of Rajputana, which goes under his name. From the times of Jasavanta Siṅgha I to about a century ago, *khyātas* continued to be compiled, probably by the same *mutsaddīs* on about the same original lines, and the old *khyātas*, re-copied with more or less faithfulness, were integrated with the new information of more recent years. But the spirit of sincerity and impartiality which characterized the early *khyātas* was not always maintained. Truths which could be plainly told in the sixteenth century, became unpalatable in the eighteenth and had therefore to be omitted or disguised in the *khyātas* of this period. This was chiefly due to the increased susceptibilities of the Rajput Princes who from an exaggerated sense of honour wanted to obliterate the memory of every particular in the history of their family that seemed to them disgraceful or in any way likely to offer a target for criticism or ridicule. Truthful and plain language was disliked, and as the pompous eloquence of the bards was better suited to the baroque tastes of the times, the bards were desired to recast the *khyātas* into a more dignified form. Siṇḍhāyaca Dayāḷa Dāsa, a Cāraṇa, did this in Bikaner and produced a work which, though fairly accurate in the last pages dealing with contemporary or quasi-contemporary events, is distorted by a large amount of forgery in all the rest, the chief object of which is to exalt the Cāraṇas by representing the Rulers of Bikaner as owing all their power to Karaṇījī, a Cāraṇī woman who apparently lived under rāva Vīkò (end of the fifteenth century A.D.), and was deified afterwards.

It is a matter of much regret that, with only one or two exceptions, the Princes of Rajputana have not yet fully realized the fact that history is a scientific discipline, not an exercise of rhetoric and imagination. Only a man trained in critical work and in the right method of research can judge the value of the different materials, and sift facts from traditions and fiction, in the light of documentary evidence. Irresponsible statements make no history; they are like castles built in the air. The history of the Rāṭhòras which for over thirty years has been in preparation in the *Tawarikh Mehkma* of Jodhpur, when it appears, if it appears at all, will be found to possess even less value than the *Khyāta* of Bikaner by Sindhāyaca Dayāḷa Dāsa and will not lead our knowledge of the subject a single step further. Why? Because it is compiled by people who are not conversant with the proper method of research. If such histories are written for the consumption of the ignorant and credulous folk in the villages of the desert, they may yet achieve some object, though at an expense absolutely disproportionate with the results, but if they are meant for India and the world, the only object they can possibly achieve is to create a very unfavourable idea of the progressiveness of the State under whose patronage they are compiled. Thus only harm can result from them and it would be really better if such histories were never written. One can understand the reasons which make some very orthodox Princes of Rajputana hostile to historical research. Not everybody has, like the Maharaja of Bikaner, the noble courage to see the cherished traditions of his family dissected by the lancet of the critic; each Prince knows that the records of his family contain a great proportion of fiction which often masks an act of treachery, a foul murder, a defeat, an admission of subordinacy, an irregular accession, and similar unpleasant truths. It is the publication of these truths that the Princes fear. We can understand that. But, apart from the fact that most of these unpleasant truths are already known, there is another consideration which goes to prove that the publication of the Rajasthani chronicles far from doing harm, would greatly benefit the Rajputs and the Hindus in general. It is this: that the history of mediæval India has been so far compiled chiefly from the works of the Muhammadan historians. Now, the Muhammadan historians in their works represent the Rajput Princes in a very unfavourable light, these are to them "infidel dogs," "headstrong rebels" and what not, and Allah is thanked every time a Rajput is "despatched to the bottom of hell." In consequence of such unfriendly feelings the Muhammadan historians never do full justice to the very important rôle which the Rajput Princes with their gallant contingents played in the Imperial campaigns, and whereas names of Muhammadan Chiefs are abundantly given in similar connections, names of Rajput Princes are given very sparely and whenever possible omitted altogether. The publication of the Rajasthani Chronicles would redress the wrong done to the Rajputs and to the Hindus in general by the Muhammadan historians and enable us to see the reverse of the medal. For just as the Muhammadan chronicles are more copious in particulars referring to the Muhammadans, the Rajasthani Chronicles are more copious in particulars referring to the Rajputs. The ones would integrate the others, and from such an integration only good would derive to the party which has not yet made its voice heard before the tribunal of History.

But times are perhaps immature for the exploitation of the valuable mine of information contained in the Rajasthani Chronicles, and there will not be many Princes eager to follow the example of the Maharaja of Bikaner by patronizing historical research. Most of the other Princes will yet for many years to come prefer the wonderful stories of the bards to the plain language of history. It would be vain to try to persuade them; one cannot go against the times. But there is one thing which they can at least do, if they do not want histories to be compiled now. They can collect all the materials available for a history in their respective States, catalogue them, and preserve them with all the care which such precious documents demand. Time will come when their descendants will cease to believe the stories of the bards and will search for materials from which to compile a real history. And if they will not find them, they will have painfully to confess to the world that nothing positive is known about the history of their State and of their family. Much has gone lost already, and the necessity for preserving what has been left could never be inculcated too strongly.

Now I proceed to give a few specimens of the different styles prevailing in the different compositions, which I have grouped together under the generical denomination of Rajasthani Chronicles. Though the tyranny of space will not allow me to give a large selection, such as the vastity of the subject would demand, I hope that by a judicious choice of the most typical examples, I shall be able to give the reader a fairly wide glimpse of the main features of this unexplored field of the historical literature of Rajputana.

The first specimen which I give below, is taken from an historical sketch of the Rāṭhòras contained in an old manuscript preserved in the Darbar Library in the Fort of Bikaner,[1] and is meant to illustrate the *vaṃśāvalī*s which, as pointed out above, were the first historical works to appear on the scene at about the time of Akbar. The present work is just referable to Akbar's time, it having been composed either during the last years of the rule of rāva Kalyāṇa Mala of Bikaner, who died in Saṃvat 1630, or during the rule of his son and successor rājā Rāya Siṅgha. It is written in an archaic form of Marwari, and contains an account of the principal events in the history of the Rāṭhòṛas, from Sīhò, the conqueror of Pālī, down to rāva Kalyāṇa Mala of Bikaner, mixed with pedigrees. It is therefore both descriptive and genealogical, on the whole a very uncouth composition, written in the plainest possible form, not without some charm of naïveté. I give below the first part of the work from the beginning down to the death of Cū̃ḍò. It will be noticed that in the first lines the origin of the Rāṭhòṛas is traced to Sīhò who is represented as an emigrant from Kanauj and at the same time as a contemporary of Solaṅkī Mūḷa Rāja of Gujarat. This must have been the tradition current about Sīhò in those times. A very interesting particular is that Dhā̃dhala is mentioned as the elder son of Āsathāna, whereas in the later genealogies Dhūhaṛa is represented as the elder and Dhā̃dhala as the younger. Another interesting particular is that concerning the murder of a son of Reṇū by the Cāraṇas, which is related in the first page. From it we may conclude with certainty that the present *vaṃśāvalī* was not composed by a Cāraṇa. We possess another later recension of this work which is apparently referable to a Cāraṇa,[1] and it is noteworthy that in this later recension while the narrative has been amplified by the addition of new particulars and the insertion of testimonial songs, the particular of the Cāraṇas murdering the son of Reṇū has been omitted altogether. The author of the present work might possibly be a Bhāṭa.

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[1] MS. 2 of *Descr. Cat. of Bard. and Histl. MSS.*, sect. i, pt. ii, pp. 16-18.

(Extr. 1 :) राजि श्रीसीहौजी कनवज ऊती[2] आ[इ] खेड़ रहियौ पछै श्रीद्वारकाजी री [जात नूँ][3] हालियौ सु विचालै पाटण मू[ल़]राज सोल़ङ्की री रजवार सु लाखौ फु[ला]णी उजाड़ घणाँ किया सु ते रै लियै सीहैजी[4] नूँ[3] राखै पछै सीहैजी कह्यौ[5] जु जात करि नै घिरतौ आईस पछै घिरता आया ताहरा लाखौ फुलाणी मारियौ पछै सीहैजी नूँ मूल़राज परनाइ[6] नै खेड़ मेल्हिया

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[1] MS. 30 of *Op. cit.*

[2] ऊंती. [3] नुं, [4] सीहनै, [5] कह्यो, [6] °नाय.

सीहैजी रा दीकरा

[१] आस्थम खेड़ (?) ऊवौ

[१] सोनग ईडर ऊवौ

१ अजौ धाट ऊवौ

१ रेणू[1] चारणाँ नूँ जीमातौ सु चारणाँ रेणू रौ दीकरौ मारियौ सु रिणू[2] कहौ किऊँ[3] नही ताहरा चारणाँ नूँ कहौ थे रेणू रौ धरा कहाजौ

आसथान रै दीकरा २ ऊवा

१ धाँधल वडौ दीकरौ

[१] धूहड़ियौ लोहड़ौ ते रै राइपाल[4] [महि]रेलण[5] ऊवौ[6]

धाँधल टीकै ऊवौ सु धाँधल रा दीकरा

१ नाभल टीकै ऊतौ सु अपूत ऊवौ

१ ऊदल लूणसै री बयर घरि घाती ऊती

१ खाखू ते रौ दीकरौ आसल ऊवौ

२ पाबू नै बूड़ौ गायाँ रै वाँसै वाहर चढिया ऊता सु खींचवन्द जीँदराइ[6b] खीची मारिया

ऊदल टीकै ऊवौ सु ऊदल रा दीकरा

२ चरूसुकाल[7] चूँडराइ[8] नै साँगण बि ऊवा सु पाटण रै धणी वीसलदे कन्है रहता सु ऊथ[9] वीसलदे चूक करि[10] नै मारिया जु लूणसै री बयर ऊदल घरि घाती ऊती तिण वेई ता पछै खाखू रौ दीकरौ आसल ऊवौ सु ताँह नूँ मारि[11] नै महिरेलण राइपाल टीकौ लियौ

ता पछै ईतरा ऊवा[12]

१ कन्हराउ राइपालौत

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[1] रेणु, [2] *Sic* for रे°, [3] किउं, [4] राय°, [5] ...रलैण,
[6] ऊवा(?), [6b] °राव, [7] °सुकल, [8] °राय, [9] उथ,
[10] कर, [11] मार, [12] Between this line and the next the MS. inserts १ महिरलण रायपाल धुहड़िये रो दीकरो, which I think it better to omit.

१ जाल्हण कन्हराओत

१ छाडौजी जाल्हणौत

१ तीडौजी छाडाउत

१ सलखौ तीडाउत

सलखौजी टीकै ऊता सु सलखैजी रा दीकरा

१ मालौजी महेवै ऊवा धरिती घणी लीवी कोटड़ौ वाहड़मेर बीजीही घणी लीवी

१ जैतमाल

१ वीरमजी

१ सोभित सिन्ध रे गाँवे रहतौ पछै गायाँ लिया[1] ऊता[2] सु वाहर चढियौ ऊतौ सु ऊथ मारियौ

राजि श्रीवीरमजी रा दीकरा

१ गोगादेजी पदोलाई.तलाइया जोइयाँ नै भा°[3] राणगदे मारियौ

१ देवराज

१ जैसिङ्घ[4]

१ राजि श्रीचूँवडौजी[5]

तथा वीरमजी महेवै मालैजी कन्है रहता नै जोइया भटनैर खारबारै रै [रहै][6] आपत माहै वुरौ हालियौ पछै जोइयै लूणै नूँ चूँवडराइ[7] मारियौ पछै लूणै रा दीकरा देपाल लखू वेउ उचलि[8] नै महेवै मालै कन्है गया पछै वीरमजी जो[इ]याँ सूँ[9] वात कीवी जु मालै नूँ माराँ[10] ताहरा मालै नूँ खबर ऊई ताहरा वीरम नै जोइया देपाल लखू बिऊँ नूँ काढिया सु वीरमजी नागौर रै धणी कन्है आइ[11] रहा नै जोइया देपाल लखू काहूनी[12] आइ[11] रहा पछै काहूनी रा ऊठिया चूँवडराइ मारियौ ता पछै उथै रहा नै वीरमजी नागौर रहता सु पाति-

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[1] लीया, [2] Notice the masculine, [3] For भाटी, [4] जैसंघ,
[5] चुवडोजी, [6] Added between the lines, [7] चुवडराय,
[8] उचल. [9] सुं. [10] मारा, [11] आय, [12] काऊँनो.

साही मारग मारि[1] नै जाँगल़ साँखलै ऊदै [मूँजाउत][2] कन्है कोटि माहे राखियौ पछै पातिसाही वाहर आई सु वीरम ऊदै कन्है माँगै ताहरा ऊदौ दियै नही पछै ऊदै नूँ वेसासि[3] [नै] गेहरियौ ताहरा खाल काढि[4] नै मारियौ ताहरा फौज अपूठी गई ताहरा साँखलै वीरम नूँ कहौ[5] जु हमै नीसरि[6] ताहरा वीरम नीसरि[6] नै जोइयै देपाल़ दलै[7]. सूँ वात करि नै वडेरण आइ गाडा छोडिया ताहरा मारग रौ हिसौ चौथ जोइयै वीरम नूँ दीन्हौ सु ईथ[8] वीरम रहै पछै वीरम माँगल़ियाँ रै विवाह कियौ ता पछै जोइयाँ रौ उजाड़ करण लागौ मारग सगल़ै रौ हिसौ लियण लागौ सु ताँ ता[9] तौ जोइये किऊ न कहौ पिण भाटी जसौ बूकण देपाल़ रौ साल़ौ मारि[10] नै गाडा वित सभरणा ले आयौ पछै फरवास मण्डोवरियै रौ वाढियौ ताहरा जोइयाँ कस कियौ पछै वडेरण छाडि[11] नै छीला सीहथल़ कन्है छै सु ऊथ आइ रहौ पछै वीरम सूँ गावा २० त°[12] २५ री वसती[13] उचल़ी ऊती सु जोइया मन्दौ दलौ साथ करि[14] नै वीरम रा वसता[15] ऊपरि[16] आया ताहरा वसता गाँव मारिया मारि[17] नै वित ले नीसरिया वाँसिया वीरम साथ ले नै वाहर चढियौ पछै वारधुवल (?) रै ताल़ वीरमजी आदमी १४० सूँ मारिया ताहरा वीरम कहौ थोरी पूनड़ै नूँ जु[18] जोइया साबता गया ताहरा पूनड़ै डाँगड़ै सूँ सर १ वाहौ तिहि[19] देपाल़ रहियौ सु वीरमजी नै देपाल़ वेउ रहा ।

पछै वीरमजी री बइर भटियाणी चूँवडेजी नूँ मेल्हि[20] नै सती ऊई चूँवडेजी नूँ धरिती नूँ साँपि[21] नै ताहरा चारण आल्हौ ले नै काल़ाऊ गयौ नै गोगादेजी थल़ देवराज कन्हा रहा पछै गोगादेजी मोटा ऊवा ताहरा जोइयाँ रौ हेरौ कराड़ियौ नै जोइयौ धीरदे पूगल़

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[1] मार, [2] Added between the lines, [3] वेसास, [4] काढ, [5] कहो [6] नीसर, [7] देखे, [8] ईय, [9] For ताँई. [10] मार, [11] छाड, [12] For तथा, [13] वस्ती, [14] कर, [15] वस्ता, [16] ऊपर, [17] मार, [18] Here the MS. had first कहो. which was subsequently corrected into जु, [19] तिह, [20] मेल्ह. [21] सांप .

भाटी राणगदे रै परणीजण गयौ ऊतौ नै वाँसिया गोगादेजी साथ करि नै जोइयै[1] दलै ऊपरि[2] गया सु दलौ सूवतौ तेथ न रहौ बीजी ठौड़ रहौ पछै उवा ढाल़ गोगादेजी गया ताहरा घाउ[3] वाहौ सु दलै[4] रौ जावाई दीकरी सूता ऊता ताँह[5] नूँ वाहौ सु वाहण रा ऊधण वाँस माँचौ वाढि[6] नै वेउ मारिया ताहरा गोगादेजी कहौ हेरै नूँ जु चूका ताहरा दलौ बोलियौ जु मोवड़ा आया ताहरा गोगादेजी कहियौ जु म्हे ही घोड़ै चढण सारीखा ऊवा ताहरा आया पछै दलौ मारि[7] नै वित ले घिरिया ताहरा दलै रौ दीकरौ हाँसू घोड़ै पड़ाइ[8] चढि[9] नै पूगल़ धीरदे परणीजण गयौ ऊतौ तेथ गयौ पछै धीरदे नै भाटी राणगदे वाहर चढिया सु वाहर आपड़ी आगै गोगादेजी पदोल़ायाँ[10] जाइ ऊतरिया ऊता नै घोड़ा ढाल़िया ऊता सु घोड़ा हाथि[11] नाया ओथ वेढ की [ताहरा ऊदौ गोगादे रौ दीकरौ नै साहौ दलै रौ दीकरौ वेउ रहा पछै][12] गोगादेजी घावे पड़िया पग वढिया ताहरा भाटी राणगदे नूँ कहौ जु थे सगा छौ म्हारौ परवाड़ौ लो ताहरा राणगदे कहौ ते सरीखा विसट पड़ै छै[12b] ताहरौ हूं परवाड़ौ लेईस पछै धीरदे मदवाण कहौ जु वैर म्हारौ छै हूँ परवाड़ौ लेईस पछै धीरदे घोड़ै ऊती ऊतरि[13] नै आयौ सु गोगादेजी नूँ खेतपाल़ रौ वर ऊतौ जु हेकै दोहरी वेल़ा तूँ चीतारीस ताहरा आईस सु ओथ चीतारियौ ताहरा गोगादेजी पगे वढिया ऊठि[14] नै धीरदे नूँ घाउ[15] वाहौ ऊथ धीरदे पड़ियौ ताहरा गोगादेजी हसियौ ताहरा धीरदे कहौ जु बल़िया ददकाल़ा आपण हड़ मेलियौ (?)[16] ताहरा गोगादेजी कहियौ जु जोइया नै म्हे सारीखी ऊई भै हमै कोई म्हारौ कियै साँभल़तौ भाटी राणगदे सूँ विसटकारी रौ वैर छै सु लेज्यो आ वात तौ इयै रही ।

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[1] जोईय, [2] ऊपर, [3] घाव, [4] दलो, [5] ताह, [6] वाढ, [7] मार,
[8] *Cfr.* पड़ाइयै घोड़े चढि (Nèṇa Sī's *Gogā De rī Vāta*), [9] चढ,
[10] °या, [11] हाथ, [12] The words in brackets are an interlinear addition,
[12b] *Cfr.* ते सारीखाँ विसटाँ रौ म्हे परवाड़ौ लेता फिराँ छाँ (Nèṇa Sī, *ibid.*),
[13] ऊतर, [14] ऊठ, [15] घाव, [16] *Cfr.* बल़िया काल़ादाँद आपै हर मेलिया (Nèṇa Sī, *ibid.*).

हमै चूँवडौजी काल़ाऊ रहै सु चूँवडौजी[1] मोटा ऊवा ताहरा महेवै मालौजी[2] कन्है गया ओथ वाणिया रात मारि[3] नै वित ले नै बैठौ खावै ईथ सै रहै पछै साँखलाँ रा नाल़ेर आया ऊता सु चूँवडैजी[4] नूँ जान साथ लियौ ऊतौ सु ताहरा साँखलै वीसल़दे कहौ जु चूँवडौ सगल़ाँ रौ धणी ऊसी ताहरा चूँवडौ ही परणायौ पछै परणीजि[5] नै महेवै आया सु ऊथ उजाड़ विगर कियौ चूँवडौ[6] न रहै ताहरा मालैजी कहियौ जु तूँ उजाड़ करै छै ताहरा कहौ जु हूँ न करूँ पछै कहौ म्हारै[7] गल़ै हाथ लाइ[8] ताहरा न लायौ पछै खुसी ऊवौ ताहरा साल़वड़ी (?) रै थाणौ मेल्हियौ थाणौ रहै पछै साँखली [बैर][9] नूँ नै रिणमल दीकरौ चूँवडासर राखिया सु आया गया आप ही रहै नै मण्डोवर लीवी ता पछै नागौर[10] डीडवाणौ[11] ही लिया[12] आप नागौर रहै पछै रिणमलजी नूँ राणगदे परणायौ ईथ[13] जाँगल़ू साँखला रहता सु साँखलाँ री ही रजवार नीबल़ी पड़ी साँखलौ मैहराज पाँचू[14] ईथ सै रहै नै मैहराज रौ दीकरौ आल्हणसी विकूँपुर भाटी जैतौ लूणकरन राउल़ केहर राखिया ऊता सु रहता ऊथ गयौ ऊतौ पछै भा° राणगदे मारिया ते माहै मैहराज रौ ही दीकरौ मारियौ सु° मैहराज रौ ही वैर ऊतौ सु मैहराज चूँवडैजी सूँ वात क[ही] ऊती जु थाहरौ तलक पड़ियौ नै म्हारौ दीकरौ मरियौ पछै अरड़कमल नूँ चूँवडैजी कहौ जु मैहराज काम कहै सु तूँ[15] करै सु मैहराज ही नागौर रै गाँव भूँडेल आइ[16] रहौ नै राणगदे विचै हेरा फिरै हीज ऊता सु ताहरा राणगदे सादै नूँ राणेहर राखियौ ऊथ सादौ रहै पछै सूताहरी १ रै धरै जीमण कराड़ियौ ऊतौ सु ऊथ सूताहरी कहौ जु म्हारै धणी री दीकरी [छै] सादै लाइक छै ओथ सादै कहौ जु मो नूँ आँखियाँ

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[1] चुडौजी. [2] Notice the use of the nominative form in an oblique construction, [3] सार. [4] चुडंजो. [5] °णीज, [6] चुडो, [7] म्हारो, [8] ल़ाय, [9] Added over the line, [10] मंडोवर, evidently a slip of the copyist. The context shows that we should read नागौर, [11] °वणो, [12] लीया, [13] इ्थ, [14] पांचु, [15] तु, [16] आय.

दिखालि[1] पछै तीजाँ रै दीहाड़ै सूताहरी ओडीट मोहिलाँ रै गाँव आई ऊथ सादै नूँ दिखाल़ी ताहरा सादै विवाह[2] कियौ सु घिरता आवता साँखलौ मैहराज हेरौ कराड़ियौ नै अरड़कमल चूँडाउत नूँ नागौर ऊती ले नै चढियौ पछै आपड़िया सादौ दाढाल़ी नवौ साधासर कहीजै तेथ मारियौ पछै मोहिल सादै री बयर वाँह १ वाढि[3] नै राणगदे नूँ मेल्ही जु सुसरै नूँ दिखाल़ज्यो[4] जु कहिसी किही कुराँड रै लियै मारियौ सु हूँ इसड़ी ऊती नै हूँई बल़ूँ कूँ ।

सादै नूँ अरड़कमल मैहराज मारि[5] नै पाछा आया सु राणगदे रौ दीकरौ १ ऊदौ पेहली भाटी केल्हण मारियौ ऊतौ विकूँपुर भा° जैतौ लूणकरन मारिया ते रै वैर नै बीजौ सादौ अरड़कमल मारियौ सु राणगदे रा बेउ दीकरा मारिया ताहरा राणगदे काल़ा बल़दाँ नै लूगड़ा[6] काल़ा करि[7] नै जेसल़मेर राउल़ केहर कन्है गयौ पछै राउल़ साम्हौ आइ[8] नै [मि]ल़ियौ[9] ताहरा कहौ जु म्हारौ वैर राठौड़ाँ सूँ छै पछै राउल़ रौ साथ ले नै अपूठौ आयौ पछै साँखलौ मैहराज भूँडेल नागौर रै गाँव मारियौ तरै वाँसै राउ चूँवडौ[10] रड़ौद (?)[11] नागौर रै गाँव ऊतौ उठा ऊ[ती] चढि[12] नै वाँसै ऊवौ पछै नाल़ कन्है आयौ ऊथ पाणी न हौ ताहरा वाघुर आया पछै जाँभ वाघोड़ मिल़ियौ ताहरा[13] जाँभ नूँ कहौ जु तो कन्हा गोगादे रौ ही वैर छै पिण तूँ पाणी पावाड़ै नै भा° राणगदे माराड़ै तौ वैर बकिसियौ पछै पाणी ही पायौ कल़सिया भरिया ऊता ताँह[14] मन्हा नै घोड़ा वाघुर पाया नै साथ होइ[15] नै आघा ताणिया पछै वाहर आपड़ी राणगदे लोहरल़ाया तल़ायाँ[16] मारियौ मारि[17] नै नागौर अपूठा आया पछै कितरे हेक दीहाड़ै जेसल़मेर रै धणी केल्हण नूँ कहाड़ियौ जु राठौड़ाँ कन्है वैर छै पछै

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[1] दिषाल, [2] वावाह, [3] वाढ, [4] °ज्या, [5] मार,
[6] °ड़ौ. [7] कर, [8] आय, [9] लीयो, [10] चुडो,
[11] *Cfr.* झाडोदराँ गावाँ (MS. 30 *of Descr. Cat. of Bard. and Histl. MSS.* pt. i, sect. ii), [12] चढ, [13] °र, [14] ताह, [15] होई,
[16] °या, [17] मार.

केल्हण मुलतान रै पातिसाह कन्है रहतौ सु पातिसाह[1] आगै हरोवल होइ नै फौजां दिली ऊपरि[2] गया[3] ऊती पछै मुलतान री फौजाँ नै दिली री[4] फौजाँ ले नै राउ चूँवडै[5] ऊपरि[2] नागौर आयौ राउ चूँवडौ[6] नागौर मारियो पछै केल्हण अपूठौ गयौ।

(Translation :) The distinguished chief Sīhò from Kanauj came and settled in Kheṛa. Afterwards he started for a pilgrimage to Dvārikā. On his way [thereto he had to pass through] Pāṭaṇa, the principality of the Solaṇkī Mūḷa Rāja. [There] Lākhò Phulāṇī had made great devastations. For the sake of him [Mūḷa Rāja] was trying to detain Sīhò, [but] afterwards Sīhò said : " After having performed [my] pilgrimage. I shall return back [to thee." And accordingly he went and] then returned back and slew Lākhò Phulāṇī. Then Mūḷa Rāja espoused [his daughter] to Sīhò and gave him leave [to return] to Kheṛa.

[And these were] the children of Sīhò :—

1. Āsthama,[7] [who] ruled over Kheṛa.
2. Sonaga, [who] ruled over Īḍara.
3. Ajò, [who] ruled over Dhāṭa.
4. Reṇū. [The last-mentioned one] used to feast Cāraṇas. Now [one day] the Cāraṇas murdered the son of Reṇū. Reṇū did not reproach them in the least, [but] subsequently he said to the Cāraṇas : " Be ye called the herd of Reṇū ! " [8]

Āsathāna had two children, [to wit] :

1. Dhā̃dhala, the elder child.
2. Dhūhaṛiyò, the younger. The latter's [child] was Rāya Pāḷa Mahirelaṇa.

Dhā̃dhala succeeded [his father], and [these were] the children of Dhā̃dhala :

1. Nābhala, [who] was the successor and died childless.
2. Ūdala, [who] had abducted the wife of Lūṇasò.
3. Khākhū. His child was Āsala.
4-5. Pābū and Būṛò. These had gone to rescue [some stolen] kine and were slain at Khīcū̃da by Jīda Rā̃va Khīcī.[9]

Ūdala succeeded, and [these were] the children of Ūdala :

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[1] पात°, [2] ऊपर, [3] Notice the masc. termination.

[4] रा, [5] चुंडे, [6] चुंडो.

[7] The same name as Āsathāna, q. v. below.

[8] The meaning of the phrase is not quite clear, but probably the word रेणू is here used in the double sense of " Reṇū, pr. n." and *reṇū* f. " Earth." One of the epithets of the Cāraṇas is *reṇava* (Murāri Dāna's *Ḍiṅgala Koša*, ii, 222).

[9] For the story of Pābū, see *Progr. Rep.* for 1915, in *Journ. As. Soc. of Be.*, xii, pp. 106-114.

1-2. Carūsugāḷa [1] Cũḍa Rāya and Sãgaṇa, two [children. These] were staying with Vīsaḷa De, the ruler of Pāṭaṇa, and there Vīsaḷa De treacherously slew them, because Ūdala had abducted the wife of Lūṇasò. On account of that [he slew them]. Subsequently, Mahirelaṇa Rāva Pāḷa slew Āsala, the child who had been born to Khākhū, and usurped the succession.

After which, there were so many successors :—
Kanha Rāva, son of Rāya Pāḷa.
Jālhaṇa, son of Kanha Rāva.
Chāḍò, son of Jālhaṇa.
Tīḍò, son of Chāḍò.
Saḷakhò, son of Tīḍò.

Saḷakhò was the successor [of Tīḍò] and [these were] the children of Saḷakhò :—

1. Mālò, [who] ruled over Mahevò. [He] conquered much land. [He] conquered Koṭaṛò, Bāhaṛamera, and much more [land].
2. Jèta Māla.
3. Vīrama.
4. Sobhita. He lived in the villages of Sindh. Afterwards [some one] stole [his] kine and he ran to the rescue, and there he was slain.

[Now, these were] the children of the distinguished chief Vīrama :—

1. Gogā De, [who] was slain by the Johiyās and the Bhāṭī Rāṇaga De near the Padoḷāī pond.
2. Deva Rāja.
3. Jè Siṅgha.
4. The distinguished chief Cũḍò.

Now, Vīrama was staying in Mahevò with Mālò [his brother]. And the Johiyās inhabited [the territory] of Bhaṭanèra and Khārabārò. Enmity arose between [the Rāṭhòṛas and the Johiyās.] Afterwards Cũḍa Rāya slew the Johiyò Lūṇò. Then the children of Lūṇò, De Pāḷa and Lakhū, both emigrated and went to Mālò in Mahevò. Then Vīrama conspired with the Johiyās : "Let us kill Mālò !" And Mālò came to know [of it], and expelled Vīrama and [with him] also the two Johiyās De Pāḷa and Lakhū. Now, Vīrama went to stay with the Ruler of Nāgòra, and the Johiyās De Pāḷa and Lakhū went to reside at Kāhūnī. Afterwards from Kāhūnī they fell on Cũḍa Rāya and slew him. And thereafter they [continued to] stay there. And Vīrama was staying at Nāgòra. Now [once upon a time he] made a robbery on the Imperial road, and then was sheltered by the Sãkhalò Ūdò Mũjāvata of Jãgaḷū in the fort. Afterwards the Imperials came in pursuit, and they were demanding Vīrama from Ūdò, and Ūdò would not deliver [him]. Then they cajoled Ūdò and seized him and stripping the skin off his body, they killed him. And then the Imperial force withdrew, and the Sā̃khalās said to Vīrama: "Now begone." And Vīrama went [from thence] and, after concerting with Johiyò De Pāḷa and Dalò, went and unyoked his carts at Vaḍeraṇa. And the Johiyās gave to Vīrama the fourth part of the [profits of the] road. So Vīrama began to stay there. Afterwards Vīrama took in marriage [a daughter] of the Mā̃gaḷiyās, and thereafter began to devastate [the territory] of the Johiyās, and began to seize the whole profit of the road.[1] Now, so far, the Johiyās [had] not said anything. But [one day Vīrama] fell upon the Jasò Bhāṭī[2] Būkaṇa, a brother-in-law of De Pāḷa, and took away his carts and cattle filled [as they were]. And after that he cut the Butea-tree of Maṇḍovariyò.[3] Then the Johiyās reprimanded him. Thereupon he left Vaḍeraṇa and where the tracks of the wheels (?) [are seen][4] near Sīhathaḷa, there he went to stay. Afterwards [on one occasion when] Vīrama had been robbed of a herd of 20 to 25 cows [and had gone to rescue them], the Johiyās Mandò and Dalò with a band fell on the encampment of Vīrama and devastated the villages of his camp, and took away the cattle. Vīrama with his band ran after them in pursuit, and afterwards was slain [by the Johiyās] in the plain of Vāradhuvala (?) together with 140 men. And [when about to die] Vīrama said to the Thorī Pūnaṛò: "The Johiyās are off unscathed!", and Pūnaṛò from a height shot an arrow wherefrom De Pāḷa fell. So both Vīrama and De Pāḷa fell.

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[1] An epithet which in the later Chronicles is attributed to Cũḍò Vīramòta. It means "liberal, prodigal."

Afterwards the wife of Vīrama, a Bhaṭiyāṇī, delivered Cū̃ḍò and became *satī*, after entrusting Cū̃ḍò to the [Mother] Earth. And the Cāraṇa Ālhò picked up [the infant] and took him to Kāḷāū. And Gogā De remained in the Thaḷa with Deva Rāja. Afterwards Gogā De grew big, and set a spy upon the Johiyās; and when [on one occasion] the Johiyò Dhīra De had gone to Pūgaḷa to wed in the [house] of the Bhāṭī Rāṇaga De, Gogā De profiting by his absence[5] collected a band and fell on the Johiyò Dalò. Now Dalò [that night] did not lie down in the [same cart] where he [always] used to sleep, but lay down in another place. Then Gogā De went to that side [which the spy had pointed out], and delivered a blow. Now the son-in-law and the daughter of Dalò were asleep there. And he struck them, and cutting the poles of the cart and the bamboos and the bedstead, killed them both. Then [realizing his mistake] Gogā De said to the spy: "[We] have missed!" And thereupon Dalò spoke: "Late have ye come!" And Gogā De said: "As soon as I have been able to ride a horse, have I come." Then he killed Dalò and taking the cattle [of the Johiyās], returned.

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[1] Literally: "a portion of the whole road."

[2] According to Mūhaṇòta NèṇaSī, Būkaṇa was not a Jasò, but an Ābhoriyò Bhāṭī [*Vīrama rī vāta*].

[3] I am not quite sure that *maṇḍovariyò* is a proper name here. The tradition is that Vīrama cut a Butea-tree from a graveyard of the Johiyās, could *maṇḍovariyò* be used here to indicate this graveyard ?

[4] The rendering of this passage is very doubtful, but the text does not seem to be capable of yielding any better sense.

[5] In this way I translate वाँसिया "behind, afterwards."

But Hā̃sū, a son of Dalò, mounted the steed Paṛāi and went to Pūgaḷa, where Dhīra De had gone to wed. Then Dhīra De and the Bhāṭī Rāṇaga De set off in pursuit [of Gogā De]. And the pursuers overtook [him]. Gogā De had gone[1] to halt [near] the Padoḷāī [pond] and had let his horses loose, so the horses did not come to hand. There they fought, and Ūdò, the child of Gogā De, and Sāhò, the child of Dalò, both fell; then Gogā De [himself] dropped wounded, with his feet cut. And then he said to the Bhāṭī Rāṇaga De: "Thou art my relative. Fight with me." And Rāṇaga De replied: "Like thee ordure falls. I fight with thee!" Then Dhīra De Madavāṇa said: "The feud is mine. I will fight," and then Dhīra De alighted from his horse and went [over Gogā De]. Now Gogā De had [received] a boon from a *khetapāḷa*[2] that if he thought [of him] in a time of difficulty, he would come [to him]. So [Gogā De] thought [of the *khetapāḷa*] there, and [lo!] Gogā De with his feet cut rose and struck a blow on Dhīra De. Dhīra De fell on the spot. And Gogā De laughed. And Dhīra De said: "Damned wretch!..........[5] Then Gogā De said: "The Johiyās and we have been made equal [by this revenge]. But now, if there is anywhere a man of my party hearing, [we] have [now] a feud with the Bhāṭī Rāṇaga De on account of the insult of the ordure, let him take it on himself." And this story now terminates here.

Meanwhile Cū̃ḍò was staying at Kāḷāū. And [in the course of time] Cū̃ḍò grew big, and went to [stay] with Mālò, in Mahevò. There assaulting the banias at night and seizing their wealth he used to fill his belly [with ease]. In this way he was living. Afterwards, the cocoanuts of the Sā̃khalās[4] came[5] [to Mahevò] and [those of] the marriage party took[6] Cū̃ḍò with them [to Jāgaḷū]. Now the Sā̃khalò Vīsaḷa De said: "[This] Cū̃ḍò will be the lord of all," and to Cū̃ḍò espoused

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[1] Here I have omitted to translate the आगै "previously" in the text, which seems to be superfluous.

[2] A tutelary deity.

[3] The exact meaning of the phrase which has here been omitted in the translation, is obscure, but it evidently contains some scurrilous abuse or imprecation.

[4] I.e. marriage offers.

[5] Lit.: had come.

[6] Lit.: had taken.

[his daughter]. After having [thus] wedded, [Cū̃ḍò] went [back] to Mahevò. Now there Cū̃ḍò cannot stay without making devastations. So Mālò said [to him]: "Thou makest devastations," and [Cū̃ḍò] said: "I do not make." Then [Malò] said: "Put thy hand on my neck,"[1] and [Cū̃ḍò] did not put [it]. Then [Mālò] was pleased and gave [to Cū̃ḍò] the garrison of Sāḷavaṛī. [So Cū̃ḍò] began to stay in the garrison. Afterwards he kept his Sā̃khalī wife and his child Riṇa Mala at Cū̃ḍāsara and he himself used to come and go [from one place to the other]. And he took Maṇḍovara,[2] and thereafter he took also Nāgòra and Ḍīḍavāṇò. And he was staying at Nāgòra. Afterwards Rāṇaga De espoused [his daughter] to Riṇa Mala. There at Jā̃gaḷū were staying the Sā̃khalās. Now the rule of the Sā̃khalās grew weak. The Sā̃khalò Mèha Rāja resided at Pā̃cū. But Ālhaṇa Sī, the child of Mèha Rāja, had gone [to] Vikū̃pura where the Bhāṭīs Jètò and Lūṇa Karaṇa were staying, [having been] placed there by rāvaḷa Kehara.[3] Afterwards the Bhāṭī Rāṇaga De slew them and with them slew also the child of Mèha Rāja. So Mèha Rāja too had a feud [with Rāṇaga De]. Now Mèha Rāja had said to Cū̃ḍò: "[I] have come [to stay] in thy territory, and [lo!] my child has been slain!" Then Cū̃ḍò said to Araṛaka Mala:[4] "The thing that Mèha Rāja says, that thou do." Now Mèha Rāja went to stay at Bhū̃ḍela, a village of Nāgòra, and [his] spies were wandering through[out the surroundings of] Rāṇaga De. And Rāṇaga De had kept [his child] Sādò at Rāṇehara and there Sādò was staying. Afterwards [Sādò] had caused a meal to be prepared in the house of a carpenter woman, and there the carpenter woman said: "My master has a daughter [who] is worthy of Sādo." Then[5] Sādò said: "Make me see her with my eyes." Afterwards on the day of the Tījās, the carpenter woman went to Oḍīṭa, a village of the Mohilas, and there showed [the maiden] to Sādò. And Sādò espoused her. Now when he was returning, the Sā̃khalò Mèha Rāja had him spied, and taking with himself Araṛaka Mala Cū̃ḍāvata from Nāgòra, went after him, and then they fell on him. And where Dāḍhāḷī [is, which is now] called Navò Sādhāsara, there Sādò was slain. Afterwards the Mohila bride of Sādò, chopped off one [of her] arms and sent it to Rāṇaga De [saying]: "Show it to my father-in-law. [For] he will say that [his son] was slain for the sake of some bad wench. Now like this was I. And I am now going to burn myself [with the corpse of my husband"].[6]

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[1] I.e. "Swear by my neck."

[2] Mandor.

[3] Of Jesalmer.

[4] A son of Cū̃ḍò himself.

[5] Lit.: there.

[6] For another, slightly different, version of the story see *Progr. Rep.* for 1916, in *Journ. As. Soc. of Be.*, xiii, pp. 220-221.

Having [thus] slain Sādò, Araṛaka Mala and Mèha Rāja returned back. Now [the other] child of Rāṇaga De, Ūdò, had been previously slain by the Bhāṭī Kelhaṇa for the revenge of the Bhāṭīs Jètò and Lūṇa Karaṇa who [had been] slain [by Rāṇaga De] at Vikūpura; and [now] his other son Sādò was slain by Araṛaka Mala. Thus both the children of Rāṇaga De were slain. And Rāṇaga De [driving] black bullocks and wearing black garments went to rāvaḷa Kehara in Jesalmer, [and] then [when] the Rāvaḷa went forth to meet him, he said [to the Rāvaḷa:] "I have a feud with the Rāṭhòras." Afterwards [Rāṇaga De] came back with a force [that he had obtained] from the Rāvaḷa, and at Bhūḍela, a village of Nāgòra, slew the Sā̃khalò Mèha Rāja. Then rāva Cūḍò [who] was [then] at Raṛòda (?), a village of Nāgòra, ran from there to the pursuit [of Rāṇaga De] and came near Nāḷa. And there there was no water. Vāghuras[1] came, and then [Cūḍò] met the Vāghoṛa Jhā̃bha and said [to him]: "I have with thee the feud of Gogā De, but if thou givest [me] water to drink and helpest [me] to kill the Bhāṭī Rāṇaga De, the feud is condoned [to thee]." Then [Jhā̃bha] gave [him] water to drink from his water-pots which were filled, and the Vāghuras watered his horses. And [Jhā̃bha] joined [Cūḍò] and off they went. And then the pursuers fell on Rāṇaga De near the Loharaḷāī pond, and slew [him], and having slain him they went back to Nāgòra. Afterwards, in the course of some days, the Prince of Jesalmer said to Kelhaṇa: "We have a feud with the Rāṭhòras." Then Kelhaṇa was staying with the Pātisāha of Multan, and forming the vanguard in front of the Pātisāha had gone [with an army] to Delhi; then taking both the army of Multan and the army of Delhi, he went to Nāgòra over rāva Cūḍò and there at Nāgòra rāva Cūḍò was slain. And after [wreaking this revenge] Kelhaṇa went back [to his domains].

We will now leave behind this dark period of feuds and personal enmities, and enter into a more glorious period in the history of the Rāṭhòras, when the princes are seen fighting for the land of their conquest. Cūḍò was succeeded by his son Riṇa Mala, who was murdered at Citora about the year Saṃvat 1500. Riṇa Mala's son Jodhò and Jodhò's son Vīkò are well-known names; the latter, as everybody knows, conquered the Jaṅgaḷa country and founded Bikaner in Saṃvat 1545. He was succeeded by his son Lūṇa Karaṇa, and Lūṇa Karaṇa was in his turn succeeded by his son Jèta Sī. This prince nobly fell on the field of honour in Saṃvat 1598, while defending Bikaner against an army sent over him by Māla De of Jodhpur. The particulars of the battle are related in the following extract taken from MS. 30 of *Descr. Cat. of Bard. and Histl. MSS.*, sect. i, pt. ii which, as mentioned above, contains a later recension of the same *vaṃśāvalī* whereof a specimen was given in the preceding pages. This later recension was apparently recast during the Saṃvat century 1700. The reader will notice at once the great difference in form and style from the former specimen. The testimonial *kavitta* quoted at the end, is probably genuine.

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[1] I do not know what tribe or class of people is meant by this term.

(Extr. 2:) [पछै राव मालदे]* अेक फौज वीरम पर चाढी अेक जैतसी पर कूँपौ जैतौ मेल्हिया[1] ...... तठा पछै अठै राव जैतसीजी पण फौज कर गाँव सोहवै साम्हा गया सु उठै परधानगौ फिरियौ[2] जो थे मालदे कन्है चालौ नाकनुवण करौ तद सारा ठाकुर बैठा तिकाँ री दाय आई तद जैतसीजी महेस साँखलौ बारै गाँव रौ पटायत थौ सु न बोलै तद पूछियौ कूँ[3] न बोलौ कहौ थारा भाई राठौड़ कहैहीज छै कहौ थे पण कहौ तद इयै[4] कहौ आ वात कियाँ आपणौ सिरीखपणौ भाग जासी अर काम आयाँ मै भलाँ छै सु जैतसीजी री दाय आहीज आई उमरावाँ री दाय नाई पछै उठै परधानाँ कूँपै जैतै नूँ[5] कहौ जो साँखलै वात न करण दीवी तद महेस नूँ बोलाय इहाँ[6] कहौ जो राठौड़ाँ नूँ तूँ कूँ[7] खपावै छै इयै कहौ सखरा जाब दिया पछै वेढ ऊई उमराव जैतसीजी रा भागा आप काम आया साथ माहे[8] दूजौ ही लोक काम आयौ सु रिण माँ जैतौ कूँपौ आया जद कहौ साँखलौ नाठौ दीसै छै देखाँ करड़ा जाब कहै थौ कहीक हो साँखलौ तौ मौहलाँ मै खेत पड़ौ छै अे ऊपर आया देखै तौ साँखलौ गिरणौ छै तद पूछौ साँखला गिरणौ सु घाव दोहरा लागा तद इयै कहौ जी घाव न दुखै छै पण छोटे माणसे मोटौ राव मारियौ तै गिरणूँ कूँ तद कहौ म्हाँरौ[9] बेटौ साँखलौ उण तरै हीज बोलै इण रै मुह मै धूड़ घातौ सु धूड़ घाती सावणी कहौ धरती तौ साँखलौ दाठाँ मै ले रहौ सु इण भाँत जैतसीजी काम आया उमराव भूँडा ऊवा तै समै रौ कवित ।

गौ राउत[10] वडरङ्ग
गयौ दूदौ डङ्गाली ।

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[1] मेल्हीया, [2] फिरीयौ. [3] कु, [4] ईयै. [5] नु, [6] ईहां, [7] नु तु कु, [8] महे, [9] मारौ, [10] रावत.

गौ फाल़स हरराज
    गयौ लखमणियौ क्काल़ी ।
गयौ सूँव साँगलौ
    . . . . .etc.

(Translation :) [Afterwards rāva Māla De] on the one side despatched an army over Vīrama,[1] and on the other side despatched Kũpò and Jètò [with another army] over Jèta Sī. . . . . . Thereupon our[2] rāva Jèta Sī also assembled an army and went to meet [the invaders] at the village of Sohavò. Parleys were exchanged there [and the enemy envoys said to Jèta Sī] : "Go to Māla De and bow your nose." At that time all the nobles [of Bikaner] were present, and they approved of [the conditions.] But Jèta Sī [noticing that] Mahesa, a Sãkhalò who had a fief of twelve villages, was silent, asked him : "Why do you not speak ?"—"Aren't your Rāṭhòṛa kinsmen speaking enough ?" was the reply. [Jèta Sī] insisted : "Speak you too." Then the man said : "If we do such a thing, our equality [with Jodhpur] will go by the board, while on the contrary being killed on the field is honourable." The latter advice appealed to Jèta Sī, but did not appeal to the nobles. Then the envoys [returning to the] enemy camp, reported to Kũpò and Jètò that a Sãkhalò had prevented any talk [of submission]. Thereupon [the two leaders] sent for Mahesa and asked him : "Why dost thou try to ruin the Rāṭhòṛas ?" And he [merely] said : "[I have caused them to] give a dignified reply [to your proposals]."

Afterwards [they] engaged in battle. The nobles of Jèta Sī bolted, but he [remained and] was killed on the field, and together with him others from his retinue were also killed. When Jètò and Kũpò went [to count the fallen] on the battlefield, they [began to] talk [between themselves] : "Methinks it looks as if the Sãkhalò had bolted. Nice indeed ! after all the proud language he was talking ! [Now be sure that] if the Sãkhalò is [lying] anywhere, he is lying on the field of battle of his zenana !" [They had not finished saying this than they came upon [him]. As they looked at him, [they saw that] the Sãkhalò was moaning. Then they asked him : "O Sãkhalò ! thou moanest ! do thy wounds cause thee much pain ?" And he replied : "No, sirs, it is not my wounds that cause me pain, but because inferior men have killed the great Rāva, I am [thus] moaning." Thereupon they said : "Our Sãkhalò son[3] [still] speaks the very same language.

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[1] Rāva of Meṛatò.

[2] Text : घठै "here."

[3] A low form of abuse very common in Marwar, indirectly falling on the mother of the person reviled.

Throw dust into his mouth." Dust was thrown [into the mouth of the Sā̃khalò, and] the augur [who saw it] said: "[As for this] land, [now] the Sā̃khalò holds it in his jaws." [1]

In this way Jèta Sī was killed on the battle-field, whereas his nobles dishonoured themselves. And the following verse was composed for the occasion:—

> The beggarly Rawat fled for his life,
> And Udo the bully fled too.
> And Har Raj the shrike relinquished the strife,
> And Lakhman the sheep also flew.
> Fled Sanglo the miser....etc.[2]

I shall now close the subject of the *vaṁśāvalīs*, i.e. of the early historical compositions based on the oral tradition and on the legends preserved by the bards, with a fantastical account of rāva Jodhò's pilgrimage to Gayā, derived from a work contained in MS. 15 of *Descr. Cat. of Bard. and Histl. MSS*, sect. i, pt. i. This work, which in the manuscript is designated by the title of *Vātā̃ Māravāṛi rī*, contains a collection of biographical and historical accounts mostly referring to personages who lived and events which happened during the reign of Akbar. The date of composition of the work also apparently falls within the time of Akbar. That Jodhò, the founder of Jodhpur, went in pilgrimage to Gayā and Prayāga, is an historical fact resting on a no less trustworthy authority than Gāḍaṇa Pasāita's *Jodhāyana*, a contemporary work, and that on this occasion he met the "Pūrabiyò" Sultan is also borne out by other early authorities, among which the two *Jèta Sī rā Chanda*, but the new and absurd thing in our account is the statement that after being introduced to the Sultan by a Rāṭhòṛa Karana, rājā of Kanauj, Jodhò persuaded the former to abolish certain fees which were exacted from the pilgrims at Gayā, and in return for this favour, rendered to the Sultan the service of destroying two strongholds of rebel *bhomiyā*s on his way back from Gayā. The genuineness of the testimonial song quoted at the end is doubtful, but the statement that Jodhò was introduced to the Sultan by a certain Karaṇa, ruler of Kanauj, is not without interest. A "rāi Kiran" ruler of Bhunganw (near Kanauj) is mentioned by Al-Badaoni[3] as having played a certain part in the wars between Sultan Bahlol of Delhi and his antagonist Sultan Mahmud of Jaunpur, and it is not impossible that this is the same person with the

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[1] *I.e.:* "You will not succeed in snatching this land from the Sā̃khalā̃s and the Rāvas of Bikaner."

[2] Stigmatizing verses of this kind are dreaded by the Rajput, who considers open censure, both when deserved and when not, as the greatest possible degradation Censorious compositions are called *visaḫara*, meaning "venomous," by the bards.

[3] *Muntak͟habu-t-Tawārīk͟h*, transl. by G. Ranking, Vol. I, pp. 403-4.

Rāṭhòṛa Karana, rājā of Kanauj, mentioned in the extract. Jodhò must have met Sultan Mahmud, not Sultan Bahlol, as the epithet of Pūrabiyò can only refer to the house of Sharqi.

(Extr. 3:) राउ[1] जोधौ गयांजी जात पधारिया आगरा री पाखती नीसरिया तराँ राजा करन कनवज रौ धणी राठौड़ तिण सूँ[2] जोधौजी मिल़िया तरै राजा करन पातिसाही अमराव थौ तिण पातिसाहजी नूँ गुदरायौ राउ जोधौ मारवाड़ि रौ धणी छै वडौ राजा छै गुजराति[3] रै मुंहडै इणाँ रौ मुलक छै नै हजरति गुजराति ऊपरि[4] मुहम[5] करण मतै छौ तौ राउ जोधा नूँ हजरति आप रौ करौ तराँ पातिसाहजी राजा करन नूँ[6] कयौ राउ जोधौ म्हाँ सूँ मिल़ावौ तराँ जोधौजी पातिसाहजी सूँ मिल़िया पातिसाहजी राउ जोधा नूँ वाताँ पूछी तिण रौ जवाब दियौ[7] पातिसा घणौ राजी ऊवौ मेघाडम्बर हाथी घोड़ा घणा दिया[8] और वसताँ घणी पातिसाजी दे नै कयौ वल़े चाहीज़ै सु माँगौ तद गयाजी दाण निपट घणौ लागतौ सनान रौ तिण री राउजी अर[ज*] करि नै गया रौ दाण छुडायौ पातिसाजी कयौ विचै[9] दोइ[10] गढी भोमियाँ री छै तकै थे मारिजो सु ज़ाताँ तौ जाची था तराँ न मारी वल़ताँ वेउ गढी मारी तिण वार रौ गीत।

मिल़ताँ समा वीर कुल़मण्डण[11]
दीवाणी आयौ दीवाण।
जोइ जोति तुहारी जोधा
साम्ही भेट करै सुरताण ॥ १ ॥

तिण समैं रौ इसड़ौ गीत छै।

(Translation:) Rāva Jodhò went in pilgrimage to Gayā. As he passed by Agra, there was there rājā Karana, the Rāṭhòṛa ruler of Kanauj, and Jodhò met him. Then rājā Karana, [who] was an imperial emir, represented to the Emperor: "Rāva Jodhò is the ruler of Marwar. He is a great sovereign. His country lies in front of Gujarat. So if Your Majesty has intention to make an expedition against Gujarat,

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[1] राव, [2] सु, [3] °रात, [4] उपरि, [5] मुंहम, [6] नु,
[7] दीयौ, [8] होया, [9] बिचै, [10] दोय, [11] कुल°

[then] let Your Majesty win rāva Jodhò to your side." Thereupon the Emperor said to rājā Karana: "Introduce rāva Jodhò to me," and [accordingly] Jodhò was introduced to the Emperor. The Emperor asked rāva Jodhò [some] questions, and as Jodhò answered them, the Emperor was very pleased, and gave him many umbrellas and elephants and horses. And after giving him many things, the Emperor said: "If anything more is wanted, ask." Now at that time an exceedingly high fee was exacted at Gayā for bathing, and the Rāva made a representation in regard to it and had the fee of Gayā abolished. Then the Emperor said [to Jodhò]: "In thy route there are two small forts of *bhomiyās*, these do thou attack." And Jodhò did not attack them when going, insomuch as he was a pilgrim then, but when coming back he attacked both the forts. And on that occasion the following song was composed:—

His kinsman he met, ornament of the race,
And straight to the Court then went the Diwan.
Beholding, O Jodhò, the light of thy face,
Before thee his gifts displays the Sultan!

Such a song was composed on that occasion.

That accounts of events which took place centuries before are always more or less inaccurate, especially when based on mere traditions, is easily understood. But if a certain amount of inaccuracy is excusable, wilful alterations and misleading forgeries are not, whatever the purpose for which they are introduced. Now, the Cāraṇas have at all times been great masters of forgeries: they have invented wonderful stories and to arm them with some kind of sanction, have often documented them with apocryphal testimonial songs. Had the Cāraṇas been as clever as they are wily, they would have clad their counterfeits in the garb of probability, thereby making detection difficult, but fortunately for us and for history, they have always lacked the sense of discriminating between possible and impossible, and consequently most of their forgeries are so absurd and inconsistent that they can deceive only fools. I have given above an extract containing an account of rāva Jèta Sī's fight with the army of rāva Māla De. This account, in spite of a certain amount of inaccuracy, is on the whole sober, and apart from the anecdote relating to Mahesa, the Sā̃khalò, contains nothing to which an intelligent reader should take exception. Now, it is instructive to compare the above account with another account given by Siṇḍhāyaca Dayāḷa Dāsa in his recent "Khyāta" of Bikaner. Here we read that Māla De marched in person against Bikaner at the head of an army of twenty thousand, and that in the fight that ensued Jèta Sī went over Māla De and killed the latter's horse by a blow of his sword. Further we read that the desertion of the Bikaneri nobles was determined by the following remarkable circumstance. Jèta Sī on the eve of battle suddenly remembered that he owed a certain sum to some merchant, and wishing to pay his debt immediately, rode to Bikaner by night, without telling anybody where he was going to. The nobles soon discovered his absence, and thinking that he had fled, deserted from the camp. On coming back, Jèta Sī found himself alone, still nothing dismayed, confronted the foe and met a glorious death sword in hand. As if all these inventions were not enough, Dayāḷa Dāsa gives us the moral of the story by representing the onslaught of the Jodhpur army on Bikaner and the consequent death of Jèta Sī as a punishment inflicted on him by Karanījī, the Cāraṇī goddess, whom Jèta Sī had offended by not properly recognizing the help which he had received from her on the occasion of his fight with Kāmrān seven years before! I give below the passage containing this impudent suggestion, and I am sure that the reader will never want any more proofs of the craftiness of the Cāraṇas. The hemistich quoted in the course of the text and attributed to Vīṭhū Mehò—the author of the adespotic *Jèta Sī rò Chanda* ?—is, of course, apocryphal.

(Extr. 4:) अरु साह कमरौ जैतसीजी आगै भागौ तिण समै रा छन्द वीठू मेहै कया ।

बाई रा बाण वहै बिरदैत [1]
जोवै जुध कौतक ऊभौ जैत ।

औ वचन सुण राव जैतसीजी कयौ कै बाण बाई रा वूवा तठै भाई रा नही वूवा इतरौ वचन कहणौ मै आयौ पीछै सं० १५९८ राव मालदे फौज हजार २०००० सूँ कूँपै मैराजौत नै अरु पञ्चायण करमसीयौत नै लेय वीकानेर ऊपर आयौ ......

(Translation:) And [when] Šāh Kāmrān fled before Jèta Sī, [the bard] Vīṭhū Mehò composed quatrains on the occasion.[2] [And these contained also the following hemistich]:

Our Sister's[3] shafts are the champions that fight;
And Jet Si of the battle enjoyeth the sight.[4]

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[1] वि°.

[2] If Sayāḷa Dāsa is accurate in the statement that a Vīṭhū Mehò composed *chandas*, in honour of rāva JètaSī, this Mehò might be identified with the author of the adespotic *JètaSī rò Chanda*, mentioned in the beginning of this Report. Vīṭhū Mehò is a well-known name, and we have of him other works among which a *Pābūjī rò Chanda* (Descr. Cat., sect. ii, pt. i, 2 (*b*)).

[3] Mehò, as a Cāraṇa, could call Karanījī his sister.

[4] Meaning: the battle was fought by the supernatural power of Karanījī, and JètaSī was a mere spectator in it.

[Now] when rāva Jèta Sī heard this phrase, he remarked: "Where [thy] Sister's arrows fell, did [my] brethren's[1] arrows not fall [as well]?" This much only came to his lips. And subsequently, in the year Saṃvat 1598, rāva Māla De taking with himself [the two leaders] Kūpò Mahirājòta and Pañcāyaṇa Karamasīòta, with an army of twenty thousand, fell upon Bikaner.

We now step out of the marshes of tradition and legend on to the firm ground of history. Here is an extract from a *pīḍhiyāvaḷī* of the Rāṭhòṛas compiled during the later half of the seventeenth century A.D., under the rule of rājā Jasavanta Siṅgha I of Jodhpur, and rājā Karana Siṅgha of Bikaner.[2] The portion quoted refers to the Rāṭhòṛas of Bikaner and contains the names of the heirs to the *gaddī* from rāva Kalyāṇa-Mala, son of Jèta Sī (17th generation from Sīhò), to rājās Rāya Siṅgha (18th generation), Daḷapati Siṅgha and Sūra Siṅgha (19th generation), and Karana Siṅgha (20th generation), besides the names of the brothers of Karana Siṅgha, the names of the brothers and nephews of Sūra Siṅgha, and the names of one of the brothers of Rāya Siṅgha (PrithīRāja) and his descendants as far as the 20th generation. It will be noticed that the names of the Rulers are given in a descending order, whereas the names of their younger brothers are given in an ascending order. The account is very accurate and quite reliable, and though coming from Jodhpur, a rather unfriendly quarter, contains no attempts to place the Rulers of Bikaner in an unfavourable light nor to minimize their merits.

(Extr. 5:)

१७ | राउ[3] कल्याणमल जैतसौत सं[°] १५७५[4] रा माह सुदि ६ जन्म
. | सुक्रवार राउ कल्याणमल ही पछौ जाइ वीरमदे दूदाउत भेला
. | ऊवा नै वेउ जाइ पूरब माहे गाँठि रौ खाइ नै पातिसाह री
. | चाकरी करि नै पातिसाह नूँ[5] ले आया मु सं[०] १६०० सईकै
. | सूर पातिसाह आइ समेल लड़ाई की तठै जैतौजी कूँपौजी
. | कामि[6] आया पातिसाह जोधपुरि आयौ वीकानेर राउ[3]
. | कल्याणमल नूँ बैसाणियौ[7] मेड़तै वीरमदेजी नूँ बैसाणियौ[7]।

. १८ | राजा राइस्यङ्घ कल्याणमलौत वडौ महाराजा ऊवौ वीकानेर
. . | जूनौ गढ पञ्जाब सुधी धरती ऊती नागौर ऊतौ पहल तुर-

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[1] I.e. Rāṭhòṛa kinsmen.

[2] *MS.* 18 of *Descr. Cat. of Bard. and Histl. MSS.* sect. i, pt. i.

[3] राव, [4] १६७५, [5] नुं, [6] कांमि, [7] °णीयौ.

. . काणौ[1] जोधपुरि पातिसाह अकबर दियौ थौ वडौ दातार
. . राजा ऊभौ[2] चारणाँ रे मसाणे हाथी बाधा ... राजा राइसिङ्घजी
. . अखैराज सोनिगरा रा दोहीतरा सं[०] १६७६
. . व्रहानपुर माहे राम[3] कह्यौ ।

. . १९ दलपति राइस्यङ्घौत टीकाइत वीकानेर पछौ पातिसाह री
. . . चाकरी करण न जाइ वीकानेर वैसि रह्यौ तिण ऊपरि
. . . पातिसाहजी सूरस्यङ्घ नूँ वीकानेर दे नै दलपति ऊपरि
. . . विदा कियौ[4] दलपति सूरस्यङ्घ सूँ[5] वेढि करि नाठौ
. . . वीकानेर सूरस्यङ्घ लियौ[6] ।

. . १९ राजा[7] सूरस्यङ्घ राइस्यङ्घौत वीकानेर पटै पहला राजा
. . . राइस्यङ्घ राम कह्यौ पछौ वीकानेर दलपति नूँ दियौ[8] तरै
. . . फलोधी सूरस्यङ्घ नूँ दी थी सु पछौ वीकानेर [सूरसिङ्घ] नूँ
. . . दियौ[8] तरै[9] . फलोधी राउलै ऊई[10] सं[०] १६५२ पोस
. . . वदि १२ जन्म लाहौर माहे जन्म सं[०] १६८८ रा आसाढ
. . . वदि १४ दक्षिण माहे गाँव बोरी राम कह्यौ भटियाणी
. . . रौ बेटौ ।

. . . २० राजा[7] करण सूरस्यङ्घ रौ वीकानेर टीकाइत ।

. . . २० सत्रसाल[11] राजा[12] सूरस्यङ्घ रौ राजा[13] सूरस्यङ्घ
. . . . पहिला ही रोक माहे राखियौ[14] थौ पछौ सं[०] १६८७
. . . . उठा था नासि राउली धरती माहे आयौ थौ पछौ
. . . . व्रहानपुरि पातिसाहजी रै पगे आयौ ।

. . . २० अजौ राजा[12] सूरस्यङ्घ रौ मीच मुवौ ।

. . ३ राजा[13] सूरस्यङ्घ रा ॥

. . १९ भोपति राजा[13] राइस्यङ्घ रौ वडौ बेटौ टीकाइत सीसोदणी
. . . रौ दलपति रौ भाई सु मूहतै[15] करमचन्द विस दे

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[1] °णे, [2] ऊभौ, [3] रांम, [4] कीयौ, [5] सुं.
[6] लीयौ, [7] राव, [8] दीयौ, [9] तरैं, [10] ऊई,
[11] °सल, [12] राव, [13] राउ, [14] °षीयौ, [15] मु°.

. . . | मारियौ [1] ।
. . १९ | किसनस्यङ्घ राजा राइस्यङ्घ रौ निरबाणाँ रौ भाणेज
. . . | सं[०] १६७५ रावलै आइ चाकर ऊवौ यौ पहिला नवसरौ
. . . | दियौ [2] यौ पछौ जाखिण दी थी पछौ वले पाछौ गयौ ।
. . . २० | आसकरण किसनसिङ्घ [रौ]
. . . २० | सबल्स्यङ्घ किसनसिङ्घ रौ
. . . २० | राजस्यङ्घ किसनस्यङ्घ रौ

. . ४ राजा राइस्यङ्घ कल्याणमलौत रा ॥

. १८ | प्रिथीराज कल्याणमलौत सं° १६०६ रा मगशिर वदि १ जन्म
. . | वडा ठाकुर रा भगत ठाकुराँ नूँ वेलि रौ वडौ जस कह्यौ
. . | पातिसाही चाकर गागुरणि पटै सं[०] १६—— मुथराजी
. . | माहे राम कह्यौ ।
. . १९ | सुदरसण प्रिथीराजौत ।
. . . २० | केसरीस्यङ्घ सुदरसणौत ।
. . . २० | जगतस्यङ्घ [सुदरसणौत] ।
. . . २० | ऊकमस्यङ्घ [सुदरसणौत] ।
. . १९ | गोकलदास प्रिथीराजौत ।
. . . २० | किसनस्यङ्घ [गोकलदासौत] ।
. . . २० | नाहरखान [गोकलदासौत] ।
. . . २० | माधोसिङ्घ गोकलदासौत ।
. . . २० | गोवरधन गोकलदासौत ।

. . २ प्रिथीराज कल्याणमलौत रा ॥

(Translation :)

17th. | **Rāva Kalyāṇa Mala**, son of Jèta Sī. [His] birth [took
,, | place] on the 6th day of the bright fortnight of Māgha
,, | of the year Saṃvat 1575, Friday. Subsequently [to
,, | the death of Jèta Sī, his father,] rāva Kalyāṇa Mala
,, | went to join Vīrama De, son of Dūdò, and [then] both

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[1] °रीयौ, [2] दीयौ.

17th. went into the Poorb [where] after spending of [their]
,, purse and serving the Emperor, [they succeeded in]
,, bringing the Emperor [against Jodhpur]. In the year
,, Saṃvat 1600 the Emperor Sūr[1] came [over Jodhpur]
,, and fought [a battle] where Jètò and Kūpò were killed.
,, The Emperor entered Jodhpur, and [re]established rāva
,, Kalyāṇa Mala in Bikaner and Vīrama De in Meratò.
,, 18th. RĀJĀ RĀYA SIṄGHA, son of Kalyāṇa Mala.
,, ,, [He] was a great mahārājā. [He ruled over
,, ,, the whole] territory [from] the Old Fort of
,, ,, Bikaner to the Panjab, and had [also] Nāgòra
,, ,, and, at one time during the Muhammadan
,, ,, occupation of Jodhpur, the Emperor Akbar
,, ,, had given him [even the last-mentioned place].
,, ,, He was a very liberal rājā and tied [many]
,, ,, elephants in the cemeteries of the Cāraṇas.
,, ,, Rājā Rāya Siṅgha [was] a son-in-law of Akhè
,, ,, Rāja Sonigarò. [He] died in Saṃvat 1679 at
,, ,, Vrahānapura.[2]
,, ,, 19th. DAḶAPATI, son of Rāya Siṅgha. [He
,, ,, ,, was] the heir of Rāya Siṅgha in]
,, ,, ,, Bikaner. [But] subsequently [instead
,, ,, ,, of] going to attend on the Emperor,
,, ,, ,, he began to stay [all his time] in
,, ,, ,, Bikaner, wherefor the Emperor [be-
,, ,, ,, came annoyed with him] and bestowed
,, ,, ,, Bikaner on Sūra Siṅgha and despatch-
,, ,, ,, ed [the latter] against Daḷapati,
,, ,, ,, Daḷapati after engaging in battle with
,, ,, ,, Sūra Siṅgha, fled, and Sūra Siṅgha
,, ,, ,, took possession of Bikaner . . . . .
,, ,, 19th. RĀJĀ SŪRA SIṄGHA, son of Rāya
,, ,, ,, Siṅgha. [He obtained] the grant of
,, ,, ,, Bikaner. First [when], after the de-
,, ,, ,, mise of rājā Rāya Siṅgha, Bikaner was
,, ,, ,, given to Daḷapati, Sūra Siṅgha had
,, ,, ,, been given Phaḷodhī. Afterwards
,, ,, ,, Bikaner was given to Sūra Siṅgha and
,, ,, ,, Phaḷodhī was incorporated into the
,, ,, ,, fisc. The birth [of Sūra Siṅgha took
,, ,, ,, place] in Lahor the 12th day of the
,, ,, ,, dark fortnight of Pauṣa of the year
,, ,, ,, Saṃvat 1652; and he died in the
,, ,, ,, village of Borī in the Dêkhan the 14th
,, ,, ,, day of the dark fortnight of Āṣāḍha
,, ,, ,, of the year Saṃvat 1688. [He was]
,, ,, ,, the son of a Bhaṭiyāṇī.

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[1] Šer Šāh.

[2] Burhanpur in the Dekhan.

17th.	18th.	19th.	20th.	RĀJĀ KARANA, son of Sūra
,,	,,	,,	,,	Siṅgha. [He is the present]
,,	,,	,,	,,	ruler of Bikaner.
,,	,,	,,	20th.	SATRA SĀLA, son of Sūra
,,	,,	,,	,,	Siṅgha. Rājā Sūra Siṅgha
,,	,,	,,	,,	had first kept [him] in con-
,,	,,	,,	,,	finement, [but] afterwards,
,,	,,	,,	,,	in Saṃvat 1687, he had
,,	,,	,,	,,	escaped from there and had
,,	,,	,,	,,	entered into the fiscal terri-
,,	,,	,,	,,	tory: then he went to Vra-
,,	,,	,,	,,	hānapura and threw himself
,,	,,	,,	,,	at the feet of the Emperor.
,,	,,	,,	20th.	ĀJÒ, son of rājā Sūra Siṅgha.
,,	,,	,,	,,	[He] died a [premature]
,,	,,	,,	,,	death.
,,	,,	,,	3	[were thus in all the sons]
,,	,,	,,		of rājā Sūra Siṅgha.
,,	,,	19th.		BHOPATI, son of rājā Rāya Siṅgha.
,,	,,	,,		[He was] the eldest son [and conse-
,,	,,	,,		quently] the lawful heir. [He was
,,	,,	,,		born] of a Sīsodaṇī [and was a uter-
,,	,,	,,		ine] brother of Daḷapati. Mūhatò
,,	,,	,,		Karama Canda administered poison
,,	,,	,,		[to him] and killed [him].
,,	,,	19th.		KISANA SIṄGHA, son of rājā Rāya
,,	,,	,,		Siṅgha. [He was] a nephew of the
,,	,,	,,		Nirabāṇas.[1] In Saṃvat 1675 he had
,,	,,	,,		come to the [Bikaner] court and had
,,	,,	,,		become a regular vassal [whereupon]
,,	,,	,,		he had been given first Navasarò and
,,	,,	,,		then Jākhiṇa; [but] afterwards he
,,	,,	,,		returned [to his home].
,,	,,	,,	20th	ĀSAKARAṆA, son of Kisana
,,	,,	,,	,,	Siṅgha.
,,	,,	,,	20th.	SABAḶA SIṄGHA, son of Kisa-
,,	,,	,,	,,	na Siṅgha.
,,	,,	,,	20th.	RĀJA SIṄGHA, son of Ki-
,,	,,	,,	,,	sana Siṅgha.
,,	,,	4		[were thus in all the sons] of rājā Rāya
,,	,,	,,		Siṅgha, son of Kalyāṇa Mala.
,,	18th.			PRITHĪ RĀJA, son of Kalyāṇa Mala. [His]
,,	,,			birth [took place] on the 1st day of the dark
,,	,,			fortnight of Mārgaśīrṣa of the year Saṃvat

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[1] A curious, but in Rajputana very common, way of saying that he was the son of a Nirabāṇī woman.

17th.	18th.			1606. [He was]. a great devout of the Thākura[jī],[1] and composed a great panegyric of the Thākura[jī] in the form of a *Veli*.[2] [He was] a vassal of the Emperor and had in fief Gāguraṇa. [He] died at Mathurā in the year Saṃvat 16 . . . .
,,	,,	19th.		SUDARASAṆA, son of Prithī Rāja.
,,	,,	,,	20th.	KESARĪ SIṄGHA, son of Sudarasaṇa.
,,	,,	,,	20th.	JAGATA SIṄGHA, [son of Sudarasaṇa].
,,	,,	,,	20th.	HUKAM SIṄGHA, [son of Sudarasaṇa].
,,	,,	19th.		GOKALA DĀSA, son of Prithī Rāja.
,,	,,	,,	20th.	KISANA SIṄGHA, [son of Gokala Dāsa].
,,	,,	,,	20th.	NĀHARA KHĀN, [son of Gokala Dāsa].
,,	,,	,,	20th.	MĀDHO SIṄGHA, son of Gokala Dāsa.
,,	,,	,,	20th.	GOVARADHANA, son of Gokala Dāsa.
,,	,,	,,		2 [were thus in all the sons] of Prithī Rāja, son of Kalyāṇa Mala.

It only remains for me now to give one or two specimens of the contemporary chronicles, both old and modern. To illustrate the former, I shall quote two extracts from a *Khyāta* written towards the beginning of the seventeenth century A.D., when Jahangir was Emperor of Delhi and Gaja Siṅgha and Sūra Siṅgha were, respectively, rājās of Jodhpur and Bikaner. This *Khyāta* comes from Phaḷodhī, and was originally composed under the patronage, or at least within the jurisdiction, of the Rājā of Jodhpur. The two extracts, which are given below, have been particularly chosen for the reason that they refer to a well-known chapter in Indian history: the activities of Prince Khurram during the later part of the reign of Jahangir. The reader will thus be able to compare the version of the Marwari chronicler with that of the Muhammadan historians and form an idea of the value of the former as a supplement to the latter. I only regret that the two extracts are too short and that space would not allow me to quote at greater length. As I have pointed out above, the principal point of usefulness of the Rajasthani Chronicles is found in the ample particulars they give concerning the part played by the Rajput Princes at the

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[1] I.e. Viṣṇu.

[2] This is the famous *Veli Krisana Rukamaṇī rī* noticed towards the beginning of this Report.

Imperial Court and in the Imperial campaigns. The Muhammadan chronicles are very deficient in such particulars and on the whole afford no basis for judging what the Rajput life under the Emperors of Delhi exactly was like. The Rajasthani Chronicles draw before us a picture of the Rajput life under the Emperors, and at the same time also of the Imperial life as seen through Rajput spectacles. The difficulties in which the Rajput Princes must have found themselves on more than one occasion when the Empire was rent by internal dissensions and rebellions, are well exemplified by the two extracts quoted below. In extract 6, rājā Sūra Siṅgha of Bikaner, summoned by Jahangir on one side, and detained by Khurram on the other, finds himself in an impossible situation from which he can only extricate himself by a hurried and clandestine departure, and in extract 7 he has to bear the consequences of his loyalty to the Emperor and see his camp looted by the vindicative fury of the same Khurram, who would not forgive him his quite justifiable defection. Of the two extracts, the former contains an account of the exploits of Khurram from his marriage with the niece of Nur Mahal (Nur Jahan), to his rebellion in Mandu (1622 A.D.); and the latter an account of Khurram's successes in the Poorb (1624 A.D.) and his subsequent campal defeat at the hands of Prince Parvez and Mohbat Khan. The list of the Rajput Chiefs fallen in the last-mentioned battle, in which the name of an elephant is also included, is particularly interesting. Lists of killed and wounded are very common in the *Khyātas*, and thanks to their accuracy, often furnish data of the greatest value.

(Extr. 6:) जहाँगीर पातिसा नूर[1]महल इतमाददोला री बेटी असपखाँ री बहन तिण सूँ[2] साहजादे थकाँ यारी ऊती नै पछौ पातसा ऊवौ तरै उण रौ माँटी मारि नै उण नूँ[3] ले मौहल[4] माँ[5] घाली सं० १६६२ रा काती मा तखत बैठौ नै संवत १६६... नूरमहल मौहल[4] मा घालि नाँउ नूरमहल दियौ[6] सगलाँ मौहलाँ[4]·रै सिरै की पातसाही उण नूँ सूँपी आप उण रै वसि ऊवौ पछौ नूरमहल आप री भतीजी असपखाँ री बेटी साहजादा खुरम नूँ परणाइ नै आप ही खुरम सूँ यारी राखती पछौ नूरमहल करि नै साहिजादाँ माहै पातसा रै खुरम जोर वुहौ वरस १२ त[°][7] १३ ताँइ खुसरौ सरीखा साहजादा नूँ बन्दीखानै दिरायौ परवेज सरीखा नूँ देसोटौ दे परौ करायौ पछौ

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[1] नुर throughout, [2] सु throughout, [3] नु throughout, [4] °मो, [5] मा throughout, [6] दीयो, [7] Abbrev. for तथा.

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तत्रै[1] नूरमहल रै पहलका माँटी री बेटी नाँनी थी सु मोटी ऊई[2] तरै खुरम कह्यौ[3] आ मो नूँ परणाइ तरै नूरमहल न परणाई[4] कहै मारी भतीजी ऊपर[5] न परणाउँ[6] तरै उवा साहजादा सहरियार नूँ परणाई[4] तरै नूरमहल नै खुरम माहोमाहै माँन तूटा नूरमहल आप रौ जाँवाई[7] सहरियार हाथि झालियौ हमै खुरम नूँ हजूर था परौ काढण मती तत्रै दखिण माँ दखणिये जोरौ कियौ[3] सं[०] १६७६ तरै खुरम नूँ दखिण नूँ मेलाउण[9] लागी सु खुरम कहै हूँ तौ जाउं जौ खुसरौ बन्दीखानै छै पातिसाही नूँ औ छै वडौ छै सु ये मो नूँ सूँपौ तौ हूँ दखिण जाउँ तरै खुसरौ साहजादौ खुरम सा[हजादा] रै हवालै करि नै खुरम नूँ दखिण नूँ मेलियौ नै आप पातसा कासमीर नूरमहल नूँ केसर रा फूल दिखाउण गौ साहजादौ दखिण आयौ दखिण फतै की दखणियाँ सूँ पक्कौ वात की पक्कौ सं[०] १६७८ रा फागुण वदि १२ राते ब्रहाँनपुर माँ साहजादै साहजादौ खुसरौ बन्दीखानै थौ सु मारियौ तिण ऊपर पातसा नूँ खबरि गई[10] पातसा वेराजी ऊवौ नूरमहल घात घालती गई[10] नूरमहल पातसा नै साहजादै जीववि (*sic!*) तोड़ घाली साहजादौ तौ ब्रहाँनपुर था माँडू आयौ तत्रै खाँधार नूँ साह उबास जोरौ कियौ[8] खाँनजहाँ री पुकार आई[11] खाँधार साह उबास ली पातिसा ही कासमीर था लाहौर नूँ आयौ सं[°] १६७९ नै पातिसाही उमराव हीँदू तुरक दखिण था त्याँ नूँ पातसा तेड़ाया खाँधार मेलण नूँ तरै साहजादै खुरम ही जाणियौ जु[12] अठा सगला ही परा तेड़ाईजै[13] नै मो नूँ अठै अेकलौ राखीजै तरै किणी ही नूँ जाँण न दिया नै पातसा नूँ लिखियौ दखिण था ये सगलाँ नूँ तेड़ावौ छौ पक्कौ अठै ही तौ दखणी जोर करसी तरै पातसा साहजादा रा हिन्दुसथान रा परगना सौह तगीर किया नै कहाड़ियौ जु दखिण गुजरात माँडू पैली धरती थाँ नूँ दी छै याँ माँ तूँ[14] थारा

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[1] For तितरै, [2] ऊइ, [3] कहो, [4] °णाइ. [5] उ°,
[6] °णाउ, [7] जांवाइ, [8] कीयो, [9] For मेलावण, [10] गइ,
[11] आइ, [12] ज, [13] दूजे, [14] तु throughout.

चाकर राखि जाणौ तूँ करि अठै पातिसाही लोक केई[1] नही रहौ तरै सा[ह*]जादै ही दीठौ पातसा तौ मो सूँ लागौ तरै पातसाही उमराव अत्रा[2] तौ साहजादै पंहला विदा किया था सु किया पण बीजाँ नूँ पछौ विदा न दे अबदुलाखाँ लसकरखाँ राजा वरसिङ्घदे राजा श्रीगजसिङ्घजी अत्रा पहला विदा किया था ता पछौ विदा न दे नै पातिसाही तेड़ा सगल़ाँ नूँ आया तरै अत्रा अे[3] वल़े माँडू ताँई तौ[3] आया पण माँडू था साहजादौ विदा न दे आप रा करि राखण लागौ राजा सूर वीकानेरियौ कछवाहौ गिरधर राइसलौत रा[°] उदैसिङ्घ भगवानदासौत मेड़तियौ कछवाहौ छत्रसिङ्घ माधोसिङ्घौत क[°] हीरदेराम पछौ याँ साहजादा नूँ कह्यौ[4] म्हे[5] रहाँ पण वाँसै पातिसा माँहरी धरती तुरकाँ नूँ दे माणस बन्दी करै तरै आधी राति रा सूरसिङ्घ गिरधर उदैसिङ्घ हिरदेराम अे[3] छडा होइ नाठा डेरा मेलि मेलि नै छत्रसिङ्घ[6] साहजादा रै रह्यौ[7] तरै छत्रसिङ्घ नूँ साहजादै तीन हजारी कियौ दोसाबहातर अे[8] पातिसाही लोकाँ नूँ था सु दिया नै[9] [फरंडु ?] विदा दी कह्यौ[10] घणौ साथ ले नै वेगौ आउँ नै साहिजादौ पण छडौ ऊइ हेक ताजमहल असपखाँ री बेटी साथै ले नै हिन्दुसथान नूँ गढ रिणथँभर नूँ खड़िया तन्नै पातिसा ही लाहौर आयौ खबरि ऊई[11] साहजादौ फिरियौ ......

(Translation :) The emperor Jahangir, when still a prince, had an amour with Nur Mahal, a daughter of Itmad Dola and sister of Asap Khan. After becoming emperor, he put her husband to death and took her into his harem. In the month of Kātī of the year Saṃvat 1662 he ascended the throne, and in the year Saṃvat 166.. he took Nur Mahal into his harem, and gave her the name of Nur Mahal and raised her above all the concubines in the harem. [Not only this, but] he placed the whole Empire into her hands and he himself became her slave. Afterwards Nur Mahal married her niece—the daughter of Asap Khan—to Prince Khurram and began to be in very friendly terms with Khurram. From that time, thanks to [the favour of] Nur Mahal, Khurram [was the one] of all the

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[1] केद, [2] For अतरा, [3] अे, [4] कहो, [5] मे, [6] छत्रसिघा,
[7] रहो, [8] बै, [9] न, [10] कहो, [11] ऊद .

Princes [who] had the greatest power at [the Court of the] Emperor for twelve or thirteen years: and he caused Prince Khusru to be incarcerated and [Prince] Parvez to be banished [from the Court]. Meanwhile, the little daughter of Nur Mahal, whom she had had from her former husband, grew big, and Khurram said: "Marry her to me," but Nur Mahal did not marry her [to him, because] she was saying: "I will not marry her to my niece's husband." So she married her to Prince Shahriyar [instead]. From that time the friendly relations between Nur Mahal and Khurram were broken and Nur Mahal took to favour her son-in-law Shahriyar. Then she resolved to drive Khurram away from Court. Just about that time the Dekhanis had caused a disturbance in the Dekhan—[it was] the year Saṃvat 1676—and she tried to arrange for Khurram to be sent to the Dekhan [to quell the disturbance]. Khurram said: "I am ready to go, but Khusru who is in prison is [the heir] to the Imperial throne, [he] is the eldest [Prince]; now if you commit him to my care, then I am ready to go to the Dekhan." So Prince Khusru was made over to the custody of Prince Khurram, and Khurram was sent to the Dekhan. [Then] the Emperor himself left for Kasmir, to show to Nur Mahal the flowers of saffron. [Now] Prince [Khurram] arrived in the Dekhan and obtained a victory and then concluded an agreement with the Dekhanis. Afterwards, on the 12th day of the dark fortnight of Phālguna of the year Saṃvat 1678, at night, in Burhanpur, Prince [Khurram] killed Prince Khusru who was in prison. Information [of this fact] reached the Emperor, and the Emperor was displeased. Nur Mahal continued adding fuel to the fire [till] she completely alienated the Emperor and the Prince.

Now, the Prince from Burhanpur went to Mandu. Meanwhile Shah Ubas had created a disturbance in Kandhar, and a call for help had come from Khan Jahan [together with the news] that Kandhar had been taken by Shah Ubas. The Emperor from Kasmir went to Lahor, [it was the year] Saṃvat 1679, and summoned all the imperial emirs, both Hindu and Muhammadan, who were in the Dekhan, in order to despatch them to Kandhar. Then Prince Khurram thought: "All the [contingents] are being called away from here, and I am being left alone!", but he did not let anybody know [about his uneasiness] and wrote to the Emperor: "You are summoning from the Dekhan all the [contingents], and afterwards the Dekhanis will create a disturbance here." But the Emperor [in reply] resumed all the parganas [which] the Prince [held] in Hindustan, and notified him: "Thou hast [now] been given Gujarat and the Dekhan [with all] the territory beyond Mandu, [therefore] keep [henceforth] in thy service [the emirs] from those provinces, and let no imperial contingents from this part [of Hindustan] remain there]." Then the Prince understood: "The Emperor is indeed against me." And as for the imperial emirs, those whom the Prince had allowed to go before, were allowed to go, but afterwards to the others he was not giving permission to leave. Abdulla Khan Laskar Khan, rājā Varasiṅgha De, and rājā Gaja Siṅgha, these [were] the only ones [who] had been given permission to leave before, and after [these, the Prince] was not granting permissions to leave. Now, all [the emirs] had received the imperial summons and [in compliance with the same] all those [mentioned below] had proceeded as far as Mandu, but the Prince would not give them permission [to depart] from Mandu, [on the contrary] he began to keep them as his own men. [These were:] rājā Sūra [Siṅgha] of Bikaner, Kachavāhò Giradhara Rāisalòta, Rā[ṭhòṛa] Udè Siṅgha Bhagavānadāsòta of the Meṛatiyā branch, Kachavāhò Chatra Siṅgha Mādhosiṅghòta, and Ka[chavāhò] Hīrade Rāma. Then these said to the Prince: "We [should like to] remain [with you], but afterwards the Emperor [will confiscate] our lands and give [them] to Muhammadans and will make [our] women [his] slaves." [Accordingly] in the heart of night, Sūra Siṅgha, Giradhara, Udè Siṅgha, and Hīrade Rāma separated themselves [from the contingents] and hurried away leaving their camps behind. [Only] Chatra Siṅgha remained with the Prince [and, in recognition], the Prince created Chatra Siṅgha a commander of three thousand, granted to him the *dosābahātara* (?) which were [enjoyed by] the imperial emirs, gave [him] instant (?) leave, and told him: "I shall soon come with large forces." Then the Prince also separated himself [from the army] and taking with him only Taj Mahal, the daughter of Asap Khan, rode to the stronghold of Riṇathāँbara in Hindustan. Meanwhile the Emperor arrived at Lahor [and] the news spread that the Prince had rebelled....

(Extr. 7:) पातिसाजी काती माहे सीकरी नूँ खड़िया अजमेर था ...वल़े कासमीर गा नै खुरम साहजादौ पूरब गौ उठै पठाण घोड़ौ हजार ... भोमिया उठा रा आइ मिल़िया उठै धरती सगल़ी साहजादै [ल]ी पातिसाही लोक काढिया पातसाही उमराव ...... मारियौ हाजीपुर पटणौ साहजादै लिया[1] धरती सौह चम्पाई[2] पिरागजी[3] लगि[4] हद की तरै वल़े साहजादौ परवेज मौहबतखाँ ब्रहानपुर [थ]ा पूरब नूँ खड़िया ब्रहानपुर माहे राउ रतन सुबादार करि राखियौ नबाब दूरि कियौ[5] नबाब री वसी आगरै ले गा नबाब नूँ सैदाँ रै हवालै करि साथै लियौ पूरब माँ[6] गा तठै मीयाँ फहीम रा कागल़

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[1] लीयो, [2] चंपाइ, [3] For प्रियागजी, [4] लग, [5] कीयो, [6] मा.

साहजादा खुरम नूँ मीरजा दराब नूँ जाता[1] पकड़िया तरै परवेज मौहबतखाँ नवाब नूँ पकड़ायौ बेड़ी पहराई[2] मीयाँ फहीम ऊपरि[3] साथ आयौ फहीम कामि आयौ फहीम रा भाई[4] माँडण राड़वरौ नारणदास सौह कामि आया सं[०] १६८१ रा भादवा माहे सं[०] १६८१ रा काती सुदि १४ पूरब माहे साहिजादै खुरम नै परवेज वेढि ऊई[5] पहला खुरम सूरसिङ्घ वीकानेरिया रा डेरा ऊपरि साथ मेलियौ सूरसिङ्घ रौ डेरौ लूटि[6] गा पछौ वेढि ऊई राजा श्रीगजसिङ्घजी री ताबीन १२ हजार असवार दे हरोल किया वेढि[7] ऊई पातिसाही १००० माणस सैद कामि[8] आया माणस सौ २०० बीजा कामि[8] आया साहिजादा रा[9] अत्रा तौ सिरदार कामि[8] आया।

१ राजा भीँव राणाउत

१ पहाड़खाँ राजा वरसिङ्घदे रौ बेटौ

१ दरियाखाँ रुहेलौ

१ रा० हरीदास रामौत

१ सीसोदियौ राउ[10] कलाणदास

१ सीसोदियौ केसोदास जैमल साँगाउत[11] रौ

१ सीसोदियौ मानसिङ्घ भाण सकताउत रौ

१ हाथी जटाजोट

रा० भीँव कलाणदासौत प्रथीराज बलुवौत अे[12] पूरे लोहड़े पड़िया श्रीराजाजी उपाड़ाया साहजादा रौ घणौ कटक माणस हजार ...मरणि गा साहजादौ नै अबदुलाखाँ नासि कूटा हाथी हसम डेरा सौह पातसा रै आया पातसाही फतै ऊई[13]।

(Translation :) In the month of Kātī the Emperor marched from Ajmer to Sikri, and [thence] went again to Kasmir.

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[1] जंता, [2] °राइ, [3] उपरि, [4] भाइ, [5] ऊइ,
[6] लुटि, [7] वेढ, [8] कंम्म. [9] रौ, [10] राव,
[11] संगावत, [12] औ, [13] ऊइ.

Prince Khurram went into the Poorb. There . . . thousand Pathan horses, *bhomiyā* of the place, joined him, and the Prince took possession of all the country, expelled the Imperials, killed . . . . ., an imperial emir, took Hajipur and Patna, and subjugated all the land as far as the holy Prayāga [which he] made his boundary. Then again Prince Parvez and Mohbat Khan from Burhanpur marched [in chase of Khurram] into the Poorb. In Burhanpur they placed rāva Ratana as subedar and deposed the Nawab, transported the family (?) of the Nawab to Agra, and took the Nawab with them committing [him] to the custody of the Saiyids. [In this way] they went into the Poorb. There they intercepted letters by Mīyā̃ Fahim directed to Prince Khurram and Mirza Darab, [and in consequence] Parvez and Mohbat Khan ordered the Nawab to be imprisoned and fettered. A force attacked Mīyā̃ Fahim, and Fahim was killed and Fahim's brothers Mā̃ḍaṇa, Rāṛabarò, and Nāraṇa Dāsa were all [likewise] killed. [This happened] in [the month of] Bhādravā of [the year] Saṃvat 1681. On the 14th day of the bright fortnight of Kātī of [the same year] Saṃvat 1681, a pitched battle took place between Prince Khurram and Parvez. First Khurram despatched a detachment to attack the camp of [rājā] Sūra Siṅgha of Bikaner, and the camp of Sūra Siṅgha was looted, then the battle was engaged. Rājā Gaja Siṅgha was given the command of twelve thousand horses and formed the vanguard. The battle was engaged. Of the Imperials, 1,000 Saiyids were killed, and 200 others were killed [of the forces] of Prince [Parvez]. And of the Hindu sirdars, the following were killed :—

1. Rājā Bhī̃va Rāṇāuta,
2. Pahāṛakhān, the son of rājā Vara Siṅgha,
3. Dariyā Khān Ruhelò,
4. Rā[ṭhòṛa] Harī Dāsa Rāmòta,
5. Sīsodiyò rāva Kalyāṇa Dāsa,
6. Sīsodiyò Keso Dāsa, [the son] of Jè Mala Sā̃gāuta,
7. Sīsodiyò Māna Siṅgha, [the son] of Bhāṇa Sakatāuta,
8. The elephant Jaṭājoṭa.

Rāṭhòṛa Bhī̃va Kalyāṇadāsòta and Prithī Rāja Baluòta fell covered with wounds, and rājā [Gaja Siṅgha] had them carried away. Of Prince [Khurram] a large multitude, [no less than] . . . . thousand men, were killed. The Prince [himself] and Abdulla Khan escaped in flight, [and their] elephants, luggage (?), tents and everything fell into [the hands of the] Emperor. It was a victory for the Imperials.

The last extract, No. 8, with which I close this small selection from the Rajasthani Chronicles, is taken from the *Khyāta* of Bikaner by Sinḍhāyaca Dayāḷa Dāsa and is meant to illustrate the lines on which chronicles, or rather registers, of contemporary events were being compiled about a century ago. The subject of the extract is the accession of mahārājā Ratana Siṅgha of Bikaner in the year 1828 A.D., and a few incidents which took place immediately after it. It is a monotonous register of events, both important and trifling, recorded in chronological order, one after the other, on the same day or very shortly after the day that they happened. Evidently, it is the work of an officer especially appointed by the Darbar to record, day for day, everything that was happening in Bikaner, from important events such as the demise of a Mahārājā and the arrival of an embassy from the East India Company, to such insignificant and irrelevant occurrences as a feast given to brahmins and an offering made to a temple. The compiler must have been a regular *mutsaddī*, not Dayāḷa Dāsa who simply took these materials as he found them and incorporated them in his *Khyāta*. The account is, of course, quite accurate and reliable, as is to be expected from the fact that it is contemporary with the events described.

(Extr. 8:) सं० १८८५ वैसाख वद ५ श्रीम्हाराज[1] रतनसिङ्घजी[1b] तखत विराजिया करणम्हौल[2] मै सु[3] पह्हला तौ गाँव सेखसर रै गोदारै ... तिलक कियौ श्रीहजूर रै व[4] पीछै म्हाजन[5] रा[6] ठाकराँ वैरीसालजी सेरसिङ्घौत[7] हजूर रै तिलक कियौ पीछै वीदासर रा[6] ठाकराँ रामसिङ्घजी[1b] श्रीहजू[र*] रै तिलक कियौ पीछै रावतसर रा[6] ठाकराँ न्हारसिङ्घजी[8] तिलक कियौ ता पीछै भूकरकै रा[6] ठाकराँ अजीतसिङ्घजी[1b] हजूर रै तिलक कियौ अरु निजर श्रीजी री पह्हली तौ ठाकराँ वैरीसालजी म्हाजन[5] रा[6] करी व पीछै न्हारसिङ्घजी[8] रावतसर रा[6] करी पीछै रामसिङ्घजी वीदासर रा[6] कीवी पीछै अजीतसिङ्घजी[1b] भूकरकै रा[6] करी पीछै लालसिङ्घजी[1b] जासाणै रा[6] करी पीछै वाय रा[6] ठाकराँ रिणजीतसिङ्घजी करी पीछै गोपाल़पुरै [रा*] व ठाकराँ सङ्गामसिङ्घजी वगेरै वीदावताँ व काँधलौताँ व नारणौताँ व भाटियाँ साराँई ताजीमाँ अनुक्रम सूँ श्रीजी री निजर कीवी व निछरावल कीवी पीछै मुसदियाँ व व्हामणाँ[9] व हजूरियाँ निजर कीवी व निछरावल पीछै श्रीजी हरमिन्दर पधारिया ठाकुरजी

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[1] माराज, [1b] °सिंहजी, [2] कर्णमौल, [3] छ°, [4] वा° throughout, [5] माजन, [6] रां, [7] °सिंहोत, [8] नारसिंहजी [9] ब्रामणां.

री भेट ५ पीछै श्रीजी देवीदारै पधारिया व भेट ...... ता पीछै उदैपुर रा राणाजी श्रीभीमसिङ्घजी सं० १८८५ चैत सुद १५ देवलोक हुवा तिका मालम हुई तद हलकाराँ री जोड़ी आई मिती वैसाख वद १० सुणाया तद दस्तूर माफक तौ नौबत बन्द[1] करावण रौ हुकम दीना[2] व बारमै दिन ब्रह्मभोजन करायौ दखणा नामै रु° १) हुवौ ता पीछै सं० १८८५ वैसाख सुद[3] १५ नै लाडुवाँ रौ सिम्भूभेख हुवौ पीछै गवरनर जेनरल साहब बहादर[4] रौ खलीतौ तारीख १६ मई सन[5] १८२८ इसवी[6] रौ राजतिलक री मुबारकवादी[7] रौ आयौ खरीतौ १ दिली रै रजीडण्ट[8] कवल बूरक साहब बहादर[4] रौ आयौ श्रीदरबार स्हामाँ[9] जे मै इसौ लिख्यौ कै धौकलसिङ्घजी[10] जोधपुर रै इलाकै मै फिसाद करै है सु[11] श्रीमहाराज[12] आप रै इलाकै रा सामल नहीं हुय सकै व आप रै मुलक मै मती आण देंज्यौ तिण री मालम हुई तद हुकम दीना[13] कै सिरदाराँ साराँ नै हुकम पूगाय दौ सु[11] कोई गाँवाँ मै आवण दे नहीं व न कोई सामल हुवै पीछै सेखावत सिवजीसिङ्घजी डूँडलोद सूँ आय नै वडे म्हाराजजी[14] रौ सोग भञ्जायौ अरु आसाढ ... नै माँहता अभैसिङ्घजी सूँ दीवाणगी री खिजमत तागीर हुई व मूँधड़े वीझराज वंसीधर नै दीवाणगी अनायत हुई अरु पालखी सिरपाव बगसिया पीछै आसोज वद मै श्रीवडे म्हाराजजी[14] रै नामै ब्रह्मभोज हुवौ दखणा रु० १) हुवौ संवत १८८५ काती सुद[15] १५ सिम्भूभेख लाडवाँ रौ दूसरौ वले हुवौ पीछै उदैपुर सूँ राणा श्रीजवानसिङ्घजी टीकौ देर चाँडावत इन्दरसिङ्घजी[16] व पञ्चोली विसनाथजी नै मेलिया हाथी १ घोड़ा २ गहणा व कणठी १ सिरपेच १ कपड़े रा तौरा आया सं० १८८५ मिगसर वद ५ नै माँहता राव अभैसिङ्घजी सूरजमल नै दीवाणगी री खिजमत अनायत हुई हाथी १

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[1] बंध, [2] for दीनौ ? The MS. in several places writes धां for धौ. *Cfr.* धांकलसिंह and मांहता, [3] सुद, [4] बाहादर, [5] संन, [6] इसवी, [7] मुबार्कवादी, [8] रजीडंस, [9] सांमां, [10] धांकल°, [11] सु°, [12] श्रीमहा°, [13] दीनां, [14] माराजजी, [15] सुद, [16] इंद्र°.

पालखी सिरपाव बगसिया वीझराज वंसीधर सूँ तागीर ता पीछै मिगसर सुद ५ नै मोदी सुलताणमल सूँ मोदीखाना[1] तागीर ऊवौ मोदी नगमल नै मोदीखाना[2] बगसियौ पीछै सं० १८८५ मिगसर सुद १५ नै सिम्भूभेख लाडवाँ रौ तीसरौ वल़े ऊवौ अरु सं० १८८५ माघ सुद[3] ३ नै टीकौ सिरकार अङ्गरेजी रौ आयौ सागै मीर मुनसी इलातफात ऊसैनजी लेर आया माघ सुद ३ नै श्रीजी सिरै दरबार कर लीना[4] जिण री याद माँहतौ सिवजीराम हिन्दूमलजी[5] ले आया सिरपेच १ किलङ्गी सूधौ, कण्ठी १ मोतियाँ री, तरवार नग १, ढाल १, पाघ १ मन्दील, पाघ १ तास री, दुपटा २ जरी पलाँ रा, मुकसी तास रा थान ३, तास रा करचाँभी रा थान ४, उतरासण तास रा गोच पेच २, मुकसी रूमाल १, पसमीनै रा दुलाया २, हाथी १, हौदौ चाँदी रौ इण भाँत आयौ पीछै मीर मुनसी इलातफात ऊसैनजी नै सीख दीनी पीछै सं० १८८५ माघ सुद १५ नै सिम्भूभेख चौथौ लाडवाँ रौ वल़े ऊवौ ...

(Translation :) The 5th day of the dark fortnight of Vaiśākha [of the year] Saṃvat 1885, mahārājā Ratana Siṅgha sat on the throne in the Karaṇa Mahal palace. First [of all] the Godārò . . . . of the village of Sekhasara made the *tilaka* on His Highness's [forehead] ; then Vèrī Sāla Serasiṅghòta, *ṭhākura* of Mahājana, made the *tilaka* on His Highness's [forehead] ; then Rāma Siṅgha, *ṭhākura* of Vīdāsara, made the *tilaka* on His Highness's [forehead] ; then Nāhara Siṅgha, *ṭhākura* of Rāvatasara, made the *tilaka* [on His Highness's forehead], and thereafter Ajita Siṅgha, *ṭhākura* of Bhūkarakò, made the *tilaka* on His Highness's [forehead]. And as for the *nazars* to His Highness, first *ṭhākura* Vèrī Sāla of Mahājana presented [his] ; then Nāhara Siṅgha of Rāvatasara presented [his] ; then Rāma Siṅgha of Vīdāsara presented [his] ; then Ajīta Siṅgha of Bhūkarakò presented [his] ; then Lāla Siṅgha of Jasāṇò presented [his] ; then Riṇajīta Siṅgha, *ṭhākura* of Vāya, presented [his] ; then the Vīdāvatas of Gopāḷapurò, *ṭhākura* Saṅgrāma Siṅgha etc., and the Kandhalòtas, the Nāraṇòtas, and the Bhāṭīs, each in due succession according to his particular rank, presented their *nazars* to His Highness and made the *nicharāvala*. Then the State Officials, the Brahmins, and the Hazūrīs presented their *nazars* and [made their] *nicharāvalas*. Then His Highness went to the Haramandira and made an offer of [Rs.] 5 to the Ṭhākurajī. Then His Highness went to Devīdvārā and made an offer of [Rs.]. . . . .

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[1] षांनां, [2] °षांनां. [3] शुद, [4] लीनां. [5] हींदू?.

[Shortly] afterwards [it] became known [that] Bhīma Siṅgha, [mahā]rāṇā of Udaipur, [had] died on the 15th day of the bright fortnight of Caitra of the year Saṃvat 1885. On that occasion a couple of couriers arrived [from Udaipur], and on the 10th day of the dark fortnight of Vaiśākha communicated the [sad] tidings. Then [His Highness], according to the custom, issued orders to stop the playing of all instruments, and on the 12th day [from the demise of the Mahārāṇā] gave a banquet to the Brahmins [in which] Re. 1 per head was [distributed] in the way of alms. On the 15th day of the bright fortnight of Vaiśākha of Saṃvat 1885 there was a *simbhūbhekha*[1] of sweetmeats. Then came a letter from the Governor General, dated the 16th of May of the year 1828 A.D., [with] congratulations for the accession, and also a letter from Col Brooke, Resident at Delhi, to the address of the Darbar, in which it was written: "Dhŏkala Siṅgha is committing dacoities in the Jodhpur territory, and [I am to inform] Your Highness that none of your subjects shall be permitted to join him, [and at the same time to request you] to please not allow him to enter your territory." [His Highness] took cognizance of the matter and then and there issued [the necessary] instructions [and said]: "Convey these instructions to all the sirdars, so that no one allows [Dhŏkala Siṅgha] to enter the villages [of our territory] and no one joins him." Then the Sekhāvata Sivajī Siṅgha came from Dūḍaloda and caused the mourning for the late Mahārājā to be discontinued. On the . . . . day of Āṣāḍha, Mòhatā Abhè Siṅgha was dismissed from the office of diwan, and Mūdharò Vījha Rāja Vaṃsīdhara was appointed to the diwanship and was presented with palanquin and robes of honour. Then in the dark fortnight of Āsoja, a [second] banquet was [given] to the Brahmins in the name of the late Mahārājā, and Re. 1 per head was distributed in the way of alms. On the 15th day of the bright fortnight of Kātī of Saṃvat 1885, there was another *simbhūbhekha* of sweetmeats. Then from Udaipur the [mahā]rāṇā Javāna Siṅgha sent Cā̃ḍāvata Indra Siṅgha and Pañcolī Visa Nātha with congratulatory gifts [for His Highness's accession and with these] came: one elephant, two horses, [various] ornaments and one necklace, one *sirapeca*[2] and *tòrās* of [silk]-cloth. On the 5th day of the dark fortnight of Migasara of Saṃvat 1885, the office of diwan was conferred [again] on Mòhatā rāva Abhè Siṅgha, and he was presented with an elephant, a palanquin, and robes of honour, and Vījha Rāja Vaṃsīdhara was dismissed. [Shortly] after that, on the 5th day of the bright fortnight of Migasara, the office of confectioner was taken from *modī* Sultāṇa Mala and conferred on *modī* Naga Mala. Then on the 15th day of the bright fortnight of Migasara of Saṃvat 1885, there was a third *simbhūbhekha* of sweetmeats. On the 3rd day of the bright fortnight of Māgha of Saṃvat 1885 arrived the congratulatory gifts from the British Government, and Mīr Munšī Ilātfāt Husain came to bring them, [and on the same] 3rd day of the bright fortnight of Māgha His Highness held a solemn darbar in which Mòhatā Sivajī Rāma Hindū Mala presented a list of the [gifts which included]: one *sirapeca* with *kalaṅgī*, one necklace of pearls, one sword studded with precious stones, one shield, one turban embroidered with gold, one turban of brocade, two scarfs with the ends woven in gold thread, three pieces of *mukasī* brocade, four pieces of *karacābhī* brocade, two . . . . , one *mukasī* handkerchief, two quilts of pashmina [silk], and one elephant [with] a howdah of silver. Such [were the gifts that] arrived. Then Mīr Munšī Ilātfāt Husain was given leave [to depart]. Afterwards, on the 15th day of the bright fortnight of Māgha of 1885, there was a fourth *simbhūbhekha* of sweetmeats . . . .

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[1] A sort of banquet or charity meal given to *sādhus*, *jogīs* and other religious beggars, for meritorious purposes.

[2] A kind of ornament worn on the turban.

APPENDIX II.

THE RULING FAMILIES OF BIKANER AND JODHPUR AND THEIR CONTROVERSY ABOUT SENIORITY.

It has become customary with everyone who directly or indirectly deals with the history of the Rāṭhòṛas of Bikaner, to consider them as a junior branch of the Rāṭhòṛas of Jodhpur and utterly disregard the right asserted by the former to be considered as the senior branch. Col. Tod, the first writer of Bikaner history, in his defective and very inaccurate *Annals of Bikaner* speaks of this State as holding merely "a secondary rank amongst the principalities of Rajputana," and in his *Annals of Marwar* gives a list of the sons of rāva Jodhò in which rāva Vīkò, the founder of Bikaner, is represented as the sixth. Misled by Col. Tod's inaccuracy, Capt. P. W. Powlett and Col. K. D. Erskine in their *Bikaner Gazetteers* published in 1874 and 1910 respectively, most cathegorically assert that Vīkò was the sixth son of Jodhò, thereby implying that the ruling family of Bikaner is junior to the ruling family of Jodhpur. Any student of Rajputana history who had any acquaintance with the original Marwari

Chronicles, and therefore needed not *jurare in verba Todi*, would never make such a categorical statement in the presence of the most disparate and contradictory evidence. In fact there are hardly two Chronicles of Jodhpur or Bikaner that agree with one another in giving the same list of the thirteen, fourteen, or seventeen sons of Jodhò, in the same chronological order. All, it is true, agree in representing Nībò, who died before his father, as the eldest son, but as to the other twelve, thirteen, or sixteen sons, the Chronicles are at a variance and do not afford, at a first sight, any basis for judging who was elder and who was younger. Possibly, the very authors of the earliest Chronicles, who probably lived under Akbar, were not sure about the gradation of seniority of all the numerous sons of Jodhò, and the confusion was complicated by the partiality of the later chroniclers who, when belonging to Jodhpur, tried to represent Sātala and Sūjò as the eldest sons next to Nībò, and when belonging to Bikaner, tried to represent Vīkò even as the eldest of all. I have studied the question carefully in the light of all the several Chronicles of both Jodhpur and Bikaner to which I have had access, and have found that in the absence of any direct statement or information, there is some indirect evidence which tends to show that rāva Vīkò was elder than rāva Sūjò, the progenitor of the descendants of Jodhò who have been sitting on the *gaddī* of Jodhpur, and consequently the ruling family of Bikaner is senior to the ruling family of Jodhpur.

Futile as the question may seem to anyone who looks at it from a practical point of view and feels inclined to give more weight to greater power and wealth than to seniority, it is not a futile question to the eyes of the modern Rajput, to whom juniority in respect to a rival lateral branch means a condition of inferiority and almost humiliation. When I visited Ratlam in connection with the edition I was preparing of the *Vacanikā of Ratana Siṅgha*, in 1914, and was even without my intention made acquainted with the controversy which the ruling family of that State has with the ruling family of the neighbour State of Sitamau about seniority, I had the first living instance of the importance which the Rajput attaches to a point that in the eyes of an outsider has, if any, only an ideal value. It may therefore not seem an idle waste of time if I here enter into the question minutely, and examine all the evidence which indirectly tends to corroborate the assertion by the Rāṭhòṛas of Bikaner that they represent the senior branch.

When Riṇa Mala, the Rāṭhòṛa rāva of Maṇḍora and Sojhata, was assassinated during his sleep in the palace of rāṇò Kūbhò of Cītoṛa about the year Saṃvat 1500, his eldest son Jodhò fled from Cītoṛa and eluding the cavalry sent by the Rāṇò to pursue him, sought a refuge in the sands of the Jaṅgaḷa country.[1] Maṇḍora thus fell into the hands of Kũbhò, who established a garrison in the city and proclaimed his rule over Marwar. It was only some years afterwards that Jodhò was able to recapture Maṇḍora and reconquer the greatest part of the country that had belonged to his father. Whether the ancient capital of Maṇḍora was in a state of decay in those times, or its natural position was not deemed strong enough to safeguard its occupants against another possible attack by Cītoṛa, or the proud Rāṭhòṛas considered it humiliating that the Guhilòtas should boast to have resided for years in the palaces of the Rāva of Marwar, the fact is that shortly after recovering his paternal dominions, Jodhò shifted his capital to a stronghold which he founded on an almost inaccessible rock about 5 miles to the south of Maṇḍora, and after his own name called: Jodhpur, "the city of Jodhò." This happened in the year Saṃvat 1515.

The Chronicles say, that after founding Jodhpur, Jodhò began to divide the territory of Marwar among his sons and brothers. But an inscription which I have found near the two temples of Pābū at Koḷū, south of Phaḷodhī, dated in the year Saṁvat 1515 and referring to the rule of *rāya Sātala, the son of mahārāya Jodhò*,[2] tends to show that the partition of the land had already begun before the foundation of Jodhpur. Those were the times when the Rāṭhòṛas of Marwar were multiplying with a prodigious fecundity, and the successor to the *gaddī* had no small difficulty in providing suitable appanages for all his numerous sons. In the case of Jodhò the difficulty was perhaps greater than in the case of any other prince, for when he succeeded his father he had not less than a dozen brothers and at least as many sons to provide for. The Jodhpur Chronicles state that he overcame the difficulty and accommodated all his brothers and sons in different parts of the territory which he reconquered, but we should make a great mistake if we were to understand this statement in the sense that Jodhò reconquered the land and then apportioned it among his relatives. It is a common feature of all the Rajput Chronicles to attribute to the sovereign prince a share of credit for any successful enterprises which his vassals carry to completion during his reign, and to explain all the gains of the vassals as privileges granted to them by the prince. What probably happened is that after helping Jodhò to reconquer Maṇḍora, each Chief went and peacefully or by the force of arms settled in some part of the country, which in those times was greatly depopulated, and founded small states under the supremacy of the Rāva.[1] This supposition is confirmed by the fact that some of the sons of Jodhò went to establish themselves in places which at the time were either waste or unimportant, founding new cities or rebuilding old ones. Thus Sātala, one of the eldest sons of Jodhò who afterwards succeeded to the *gaddī* of Jodhpur, went to establish himself in the desert near Pohakaraṇa and Phaḷodhī, and founded the new city of Sātalameia. It is obvious that Jodhò would have never assigned to one of his eldest sons a fief of that kind, consisting of a desert tract without a stronghold of any importance. Evidently Sātala went there of his own initiative, possibly hoping to be able one day to conquer the whole territory of Pohakaraṇa and thus found a large state. The Rāṭhòṛas of those days were not lacking spirit of enterprise, and on the other hand the exuberant growth of the race made it imperative for them to conquer new land and provide free scope for their ambitions and ample means of subsistence for themselves and their descendants This remark will help to understand the conditions under which Vīkò left the court of his father and went to carve for himself a new state in the Jaṅgaḷa country.

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[1] The old name for the desert tract now included within the boundaries of the Bikaner State, especially the southern part of it.

[2] See "Progress Report etc." for the year 1915, in *Journ. As. Soc. of Be.* (New Series), Vol. xii [1916], p. 108.

Though some Chronicles give a smaller number, probably through omission of some of the less important names, there can be no doubt that rāva Jodhò had at least seventeen sons, whereof the names are faithfully recorded in the most accurate Chronicles. These names are, in alphabetical order, the following: Karama Sī, Kū̃pò Cā̃da Rāva, Jasavanta, Jogò, Dūdò, Nī̀bò, Bhāra Mala, Rāi Pāḷa, Vaṇavīra, Vara Siṅgha, Vīkò, Vīdò, Sātala, Sā̃vata Sī, Siva Rāja, and Sūiò[2] The eldest of all was Nī̀bò, and according to all the Chronicles, who speak of him as *kā̃vara* Nī̀bò, he was the *ṭīkāyata* or heir-apparent of Jodhò, but he died before his father, without issue. Nī̀bò had been residing for some years at Sojhata, an important stronghold, which had also been the residence of Riṇa Mala and later of Jodhò himself, before the latter founded Jodhpur.[3] By the time when Jodhò died in Saṃvat 1545, the most enterprising of his sons had all established themselves in some part of the country: Sātala at Sātalamera, Vīkò in Jaṅgaḷa, Dūdò and Vara Siṅgha at Meṛatò, Vīdò in the Mohilāvaṭī, Karama Sī at Āsopa, Bhāra Mala at Koḍhaṇò, Rāi Pāḷa at Nāharasara, Siva Rāja at Drunāṛò, Sā̃vata Sī at Khèravò. Sūjò was probably with Sātala, his uterine brother. The Chronicles do not say that Jodhò had designated any other of his sons as his heir-apparent after the death of Nībò, but he must have done so, and anyhow from a particular which is recorded in some of the oldest Chronicles and which we shall examine below, it appears that after the death of Nībò, the legitimate heir, whether by his father's designation or by his right of birth, was considered to be Jogò.

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[1] Also it is not unlikely that some of the brothers of Jodhò, who had been given fiefs under Riṇa Mala, retained these under the domination of Citoṛa, and had them simply recognized by Jodhò, when the latter re-established his authority over Marwar.

[2] *D. C.*, i, i, **18**, pp. 40*a-b*; *C.* **52**, p. 26*b*; *C.* **68**, pp. 6*b*-7*a*. (In the above, the initials *D. C.* stand for *Descriptive Catalogue of Bardic and Historical Manuscripts*, and the initial *C* stands for *Manuscripts Copied*, whereof lists are given in the Progress Reports of the Survey.

[3] Gāḍaṇa Pasāita in his *Jodhāyaṇa*, a poem on the exploits of rāva Jodhò, makes the following explicit allusion to this prince's stay at Sojhata:

मण्डियौ जोधि सोझत्ति वास
गुहिलौताँह पूजै न सास । (*D. C.*, i, i, **19**, p. 102*a*.)

Vīkò, with whom we are here particularly concerned, had long before the death of Jodhò gone to settle in Jaṅgaḷa, the country lying to the north of Jodhpur beyond the territories of Nāgòra and Phaḷodhī. The starting point for all Vīkò's conquests in this part of the country, was a small state centring in the fort of Jā̃gaḷū and held by the Sā̃khalās, a branch of the Pāvāra Rajputs, who had the title of *rāṇās*.[1] This small state had been in a position of more or less nominal subordinacy to Marwar since the days of Riṇa Mala,[2] and Jodhò himself, when driven out of Marwar, had found shelter and hospitality in the houses of the Sā̃khalās. The tradition is that Nāpò Māṇika Rāva rò, the rāṇò of Jā̃gaḷū, being menaced by the Balūcīs, went to the court of Jodhò for help, and at his request Jodhò sent to Jā̃gaḷū a force under the leadership of Vīkò, assisted by Kā̃dhala, one of Jodhò's brothers.[3] However that was, certain it is that Vīkò went to Jā̃gaḷū as a friend of Nāpò and had the latter's support in all the conquests which he subsequently made in the country to the north and east.[1] Jā̃gaḷū was bordering with the Bhāṭīs of Pūgaḷa to the north and west, with the Jāṭas to the north, and with the Mohilas to the east. Vīkò established himself at Koḍamadesara, a village on the eastern border of Pūgaḷa, founded by rāva Jodhò during his exile.[2] In a few years, the Jāṭas were completely subjugated and all the country to the very borders of Hisāra and Depāḷapura fell into the hands of Vīkò. The Mohilas, who apparently had already been defeated by rāva Jodhò some years before, were definitely crushed and their territory, known as Mohilāvatī, became the possession of Vīdò, a uterine brother of Vīkò. The Bhāṭīs of Pūgaḷa, who at first had watched with apprehension the conquests of their enterprising neighbour, became more friendly when they saw that Vīkò had no aggressive intentions in respect to them, and Sekhò, the rāva of Pūgaḷa, married to Vīkò his daughter. Meanwhile, about the year Saṃvat 1542,[3] Vīkò had begun to build a new fort a dozen miles to the east of Koḍamadesara. This was the origin of the city of Bikaner, and it was completed and populated in the year Saṃvat 1545.[4]

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[1] It appears that there were two small Sā̃khalā principalities at the time with which we are concerned, the one held by the *Jaṅgaḷavā* line of the family, and the other by the *Rūṇecā* line. The princes of both lines had the title of rāṇā. Jā̃gaḷū, with the territory around it, belonged to the Jaṅgaḷavā rāṇās. The territory of the Rūṇecās was in origin south of Nāgòra and had for its capital Rūṇa, but whether Rūṇa was still the capital of the Rūṇecās at the time of Jodhò, it is difficult to say. No mention of Rūṇa as a Sā̃khalā principality is found in the Chronicles of the time, and the Rūṇecās are often confounded with the Jaṅgaḷavās and *vice versâ*. But one thing is certain, that at the time of Jodhò the Rūṇecā principality was still in existence, for Jodhò married a daughter of the Rūṇecā rāṇò his contemporary, her name Nòraṅga De, and she was the mother of Vīkò and Vīdò.

[2] See "Progress Report, etc." for 1916 (*Journ. As. Soc. of Be.* N. S, xiii), p. 204.

[3] The above is the version of the Jodhpur Chronicles (Cfr. *C.* **52**, p. 28*a*), and it agrees with a statement in Mūhaṇòta Nèṇa Sī's *Vāta Sā̃khalā rī*: नापौ माणकराव रौ जाँगलू धणी तद बलोचै जोर दबाया तरै राव जोधा कनै जोधपुर आय नै कंवर वीका नूँ जाँगलू ले जाय धणी कियौ साँखला चाकर हुवा (*D. C.*, i, ii. **8**). The earliest Bikaner Chronicles which I have seen, simply state that Jodhò assigned to Vīkò the Jaṅgaḷa country, and to Vīdò the Mohilāvaṭī (*D. C.*, i, ii, **2**, p. 17*a*). Sindhāyaca Dayāḷa Dāsa, the latest chronicler of Bikaner, gives a different version, which is

In the same year Saṃvat 1545, rāva Jodhò died in Jodhpur. Sātala was appointed to succeed him. But from a particular preserved in the Chronicles, it appears that the legitimate successor of Jodhò after the death of Nībò, was not Sātala but Jogò. " After the demise of rāva Jodhò, writes the chronicler, [the nobles] were going to place the *ṭīkò* on the forehead of Jogò, but the latter, who had just made his ablutions, said: Wait till my hair is dry. Whereupon all said : We will not give the *ṭīkò* to him, and went and consecrated Sātala instead." [5] The

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probably nothing but his own invention. (See P. W. Powlett's *Bikaner Gazetteer*, p. 1.)

[1] The assertion by Col. Tod that Vīkò fell with his band upon the Sā̃khalās of Jā̃gaḷū and " massacred " them, is not only untrue, but also unjustifiable in that no Chronicle contains anything approaching such a statement, on the contrary all represent Nāpò as a friend and auxiliary of rāva Vīkò.

[2] See " Progress Report, etc." for 1916, pp. 217-222.

[3] *Jèta Sī rò Chanda* by Vīṭhū Sūjò, 49. Some Chronicles give the date Saṃvat 1541. Cfr. *D. C.*, i, i, **18**, p. 40*a*.

[4] Like Jodhpur, Bikaner also derives its name from its founder: *Vīkānèra* is but the vernacular form of *Vikramanagara*, meaning " the city of Vikrama, or Vīkò."

[5] राव जोधा वाँसै टीकौ जोगा नूँ देता छता पछै साँपड़ियौ थौ सु कहै सु नलाड़ सूकण दो तरै सगले ही कह्यौ इण नूँ टीकौ न दीजै तरै [टीकौ] सातल जोधाउत नूँ दियौ (*D.C.*, i, i, **18**, p. 444*b*); जोधा राउ वाँसै टीकौ जोगा नूँ देता था पछै कहै माथै पाण घालियौ थौ सु चालौ के सूकण दो तरै सातल नूँ टीकौ दियौ (From a MS. from Phaḷodhī dating from the end of the Saṃvat

very ludicrousness of the above account is a proof of the authenticity of the main information. It is easy enough to find in this story the pretext with which the chronicler tries to justify the action of the nobles in placing on the *gaddī* Sātala instead of Jogò who was the legitimate heir. And in that case the pretext adduced is a very poor one indeed. But it may also be that Jogò, when offered the *ṭīkò*, disappointed the nobles with a foolish reply like that mentioned by the chronicler and that the nobles thinking him unfit to rule, elected Sātala in his place.[1] The latter supposition is confirmed by an information concerning Jogò which we find in the *Khyāta* of Mūhaṇòta Nèṇa Sī. In his *Vāta Mohilā̃ rī*, Nèṇa Sī states that Jodhò, after defeating the Mohilas of Chāpara and the Paṭhāṇas their allies, assigned the Mohilāvaṭī to his son, kā̃vara Jogò, but as the latter was a simpleton and was unable to retain the land, his wife, a Jhālī, asked Jodhò to recall him back and assign the Mohilāvaṭī to somebody else. Accordingly, Jodhò recalled Jogò and assigned the Mohilāvaṭī to Vīdò.[2] Evihently, Jogò was a man of weak intellect, if not thoroughly inept, and this is probably the reason why he was excluded from the succession, in spite of his right of birth, which he apparently had.

It may be asked: was Sātala the legitimate successor, after the exclusion of Jogò? From the fact that his election was not contrasted nor opposed by any other claimant, at least so far as we know, it would seem that he was. Sātala was involved, it is true, in a war with Vīkò shortly afterwards, but, though the real motives that led the two brothers to fight one another are not known, it seems that the aggressor was not Vīkò, but Sātala, who allying himself with the Khān of Nāgòra, the Rāvaḷa of Jesalmer, and the Rāva of Pūgaḷa, invaded Vīkò's territory.[3] Possibly, Vīkò after the death of Jodhò, to whom

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century 1600). Cfr. also *C.* **52**, p. 29*a*, where a more detailed account is given.

[1] From the evidence of the Chronicles it appears that at the time with which we are concerned, every case of succession to the *gaddī* had to be ratified by the assembly of the nobles. That this assembly had even the power to exclude from the succession the legitimate heir, when he seemed to be unfit or otherwise undesirable, and elect another, is clearly shown by the case related above.

[2] मोहिलाँ थाँ धरती छूटी राठौड़ाँ री [साहिबी वडी] जमीयत हुई राव जोधौजी कुँवर जोगै नूँ आ ठौड़ दे [पछै ?] दी[धी] पछै आप मण्डोवर पधारिया सु कुँवर जोगौ भोळौ सौ ठाकु[र हु]तौ सु जोगा सूँ धरती रख नह आई नै धरती माहे मोहिलाँ री [द खल हुवण लागौ धरती री मोहिल विगाड़ करै (*sic*) लागा ठौड़ ठौड़ थी फिरियाद आवण लागी ताहराँ कुँवर जोगा रै वहू झाली हुती तिण आप रा सुसरा रावजी सूँ कहायौ थाहरा बेटा माहे लखण क्यूँ न छै नै धरती लीवी छै सु जाय छै जाणौ सु इलाज कीज्यौ (*D.C.*, i, ii, **8**, p. 239*b*.)

[3] See "Progress Report etc." for 1916, pp. 235-236.

he owed at least the submission of a respectful son if not that of a vassal, had refused to recognize the supremacy of the Rāva of Marwar, that Rāva his brother, and Sātala undertook the above-mentioned expedition in order to subjugate him. If this was Sātala's object, he failed in it, and the Rāva of Bikaner maintained his independence and at no period of the Bikaner history a descendant of Vīkò has ever acknowledged the supremacy of Marwar. Sātala had a very short rule, for in the year Saṃvat 1548 a Muhammadan army from Ajmer invaded Meratò and Pīpāṛa, and Sātala in opposing the invaders at Kusāṇò lost his life in the field. He died without issue.

As soon as the news of the death of Sātala reached Bikaner, Vīkò assembled a force and hastened to Jodhpur. Why? If there could possibly be any doubt concerning Vīkò's intentions, the Chronicles remove it by explicitly stating that he went to Jodhpur with the hope to succeed to the *gaddī* of Marwar. Now the mere fact that Vīkò went to Jodhpur in the hope to succeed, is sufficient to prove that he had the right to succeed, or else he, after having been a stranger to his mother country for years and having even fought against her, could have never dreamt of going there and finding the people so well disposed towards him to consent to set aside the legitimate heir and elect him in his place. On the contrary, in spite of his right to succeed, he well knew that most of the people would be hostile to him, and therefore brought a force to back his claims. That he had at least one partisan in Jodhpur, the commander of the fort,[1] a very high official in those times, is admitted by the Chronicles, all of which agree in stating that it was the commander of the fort who sent word to Vīkò to come quickly that he might be invested with the *ṭīkò* of Marwar. Naturally, the account of the Chronicles of Bikaner differs to some extent from the account given by the Chronicles of Jodhpur. According to the former, Vīkò delayed on his way to Jodhpur[2] and thus gave time to the Hāḍī Jasamā De, the mother of Sūjò, to persuade the commander of the fort to give the *ṭīkò* to her son. Vīkò arrived, and finding that Sūjò had been elected in his place, laid siege to Jodhpur, but shortly afterwards raised the siege and returned to his domains.[3] The Chronicles of Jodhpur on the other hand say that Varajā̃ga, the commander of the fort, had secretly plotted to open the gates to Vīkò, but the Riṇamalòtas of Cāḍī, who first saw the forces of Vīkò approaching, ran to Jodhpur to give warning, and prevented the opening of the gates. Thus Vīkò, finding the gates shut, retired to Manḍora and thence took his way back to Bikaner.[1] And afterwards all the Chiefs went to Varajā̃ga and reproached him saying: "What didst thou mean by calling Vīkò here ?," to which he jocously replied: "Ha! I only meant to amuse myself by stirring up the puppies of Jodhò to fight with one another!"[2] From this last particular as well as from the statement that it was Varajā̃ga who called Vīkò to Jodhpur, it is evident that Varajā̃ga had been openly favouring the election of Vīkò, and as he probably was the only Chief in Jodhpur to side with the latter, it has been possible for the Jodhpur chronicler to represent him as a plotter and almost a traitor to his country. But could Varajā̃ga, or any other sane man, have ever thought of supporting the election of Vīkò against the will of the other Chiefs, unless Vīkò had a claim as a legitimate heir, *i.e.* as the eldest of the living sons of Jodhò, Jogò excluded ?

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[1] The Bikaner Chronicles give his name as VèraSala Bhīvòta, whereas the Jodhpur Chronicles give his name as Varajāga Bhīvòta. The latter, who was a brother of the former, had commanded the Marwar forces at the battle of Kusāṇò.

[2] राउ वीकौ कोडमदेसर हूतौ हालियौ सु पैँडै माहै आवत अमल कर नै रहतौ सु ओवड़ै रौ आयौ (*D.C.*, i, ii, **2**, p. 17*b*); वीकौजी अठा सूँ चढिया वीच अमल कर सुय रह्या तै मूँ ताल लागी (*D.C.*, i, ii, **30**, p. 151*a*).

[3] Evidently, Vīkò discouraged by the *fait accompli* of the election of Sūjò and by the lack of support on the part of the Jodhpur Chiefs,

That Sūjò, the man who was appointed to succeed Sātala, was not the legitimate heir, is implicitly admitted even by the Jodhpur Chronicles. For to justify the election of Sūjò, the Chronicles produce the reason that Narò, a son of Sūjò who had settled at Phaḷodhī,[3] had been adopted by Sātala, and when the latter died, renounced his right to succeed him in favour

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abandoned the enterprise. The Bikaner Chronicles explain his renunciation to his rights as an act of magnanimity. They say that Jasamā De went to meet Vīkò, taking with her a little girl. Vīkò noticing that the girl was weeping asked the reason thereof, and on hearing that it was from thirst, took pity on the conditions of the besieged and raised the siege. One Chronicle states that Vīkò before raising the siege and renouncing his rights, extorted from Jasamā De the promise that the descendants of Sūjò would never wage war against Bikaner, and that he received from her two heirlooms originally belonging to rāva Sīhò, to wit: an image (?) of Nāgaṇacā (Nāgaṇecī), the *kuladevī* of the Rāṭhòṛas, made of *nīm*-wood, and a pair of kettledrums (*D.C.*, i, ii, **30**, p. 151*a*). In the later Chronicles, the number of these heirlooms has been increased, the Chronicle of Dayāḷa Dāsa enumerating no less than thirteen (*D.C.*, i, ii, **1**, p. 148*b*). Cfr. also the *kavitta* quoted in *D.C.*, ii, i, p. 26.

[1] *C.* **52**, p. 32*a*; *D.C.*, i, i, **19**, p. 12*b*.

[2] पछै वरजाँग भीँवौत नूँ सगलें कह्यौ वरजाँगजी थे वडा ठाकुर गढ थाँरै हवालै थे दूसड़ी कूँ करौ तरै वरजाँग कहै बैठा जोधा रा कुंकरिया लड़ावाँ छाँ (Phaḷodhī MS.); तरै मिनखाँ वरजाँग नै कह्यौ तूँ ओ कूबदियाँ किऊँ करै छै तरै वरजाँग कही कै हूँ तो राव जोधाजी रा कूकरिया घूररावाँ छाँ (*sic*) (*C.* **52**, p. 32*a*).

[3] See "Progress Report etc." for 1915 (*Journ. As. Soc. of Be.* (N.S.) xii, 1916).

of his own father Sūjò.[1] What a splendid example of filial devotion in a period when sons like Ūdò of Cītoṛa and Māla De of Jodhpur used to relieve their fathers of the burden of old age to inherit a few days earlier that power which Narò so magnanimously refused! And how ungrateful the father who, after being placed on the *gaddī* by the disinterested devotion of one of his sons, designated another son—Vāghò—to be his heir-apparent.[2] Obviously enough, the story of Narò's abdication in favour of Sūjò is merely an excuse offered as an explanation of the irregularity in the latter's election. Whether there is any truth in the statement that Sātala had adopted Narò, it is difficult to say, but even if the statement is true, the fact of the adoption of Narò could never justify the election of Sūjò. Besides, the story of the abdication of Narò in favour of his father is too absurd to be believed. It is interesting to note that one of the Bikaner Chronicles[3] also mentions the fact that a son of Sūjò, this son Vāghò, not Narò, had been adopted by Sātala, and that the same son abdicated in favour of his father. It would therefore seem that Sūjò had actually adduced the pretext of his son's adoption by Sātala to show that he had a right to succeed. But the mere fact that he had to use such a pretext shows that he had no right.

How could then Sūjò manage to obtain the *gaddī* if he had no right? How could the nobles of Marwar tolerate an infringement of the established custom, according to which the right of inheritance and succession devolves to the eldest son? There is a consideration which makes the whole thing clear. The seventeen sons of Jodhò were not born of one, but of six different mothers. Nībò, Sātala, and Sūjò were the sons of one rāṇī, the Hāḍī Jasamā De; Vīkò and Vīdò were the sons of another, the Sā̃khalī Nòraṅga De[4]; Dūdò and Vara Siṅgha were the sons of a third rāṇī, the Sonigarī Campā;

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[1] नरा नूँ राव सातल रै खोल़ दियौ थौ सो नरै आप री मा लिखमी राणी रा कह्या सूँ आप रा पिता सूजाजी नूँ जोधपुर गादी बेसाणिया (*C.* **52**, p. 36*b*).

[2] All the Chronicles combine to show that during rāva Sūjò's rule, Vāghò, and not Narò, was considered as the heir-apparent. In fact Vāghò died before Sūjò, and so did Narò, but the successor was a son of the former, not of the latter.

[3] *D.C.*, i, ii, **30**, p. 151*a*.

[4] With the help of the *Khyāta* of Mūhaṇòta Nèṇa Sī, I have succeeded in identifying the father of Nòraṅga De, whose name is given in the Chronicles as Mā̃ḍò, with the homonymous rāṇò of the Rūṇecā branch of the Sā̃khalās. His pedigrees are: 1. Vèra Sī > 2. Rāja Pāḷa > 3. Chohila > 4. Pālaṇa Sī > 5 Mèhadò > 6. Haṃsa Pāḷa > 7. Soḍhala > 8. Vīrama > 9. Cācaga > 10. Sīhaṛa > 11. Sālò > 12. Bhoja Rāja > 13. Jèta Sī > 14. Mā̃ḍò (*D.C.*, i, ii, **8**, p. 91*a*). The statement in the Chronicles that the mother of Vīkò was the daughter of a rāṇò of the Jaṅgaḷavās; is therefore incorrect. The rāṇò of Jā̃gaḷū, at the time of Jodhò and Vīkò, was Nāpò, the son of Māṇika Rāva.

and so on.[1] Now, it is a very significant fact that the successors of Jodhò, from Nībò who was appointed heir-apparent during his father's life-time, to Sātala who supplanted Jogò, and finally to Sūjò who supplanted Vīkò, were all sons of one mother, the Hāḍī Jasamā De. Evidently, and the Chronicles seem to confirm it, Jasamā De was the favourite rāṇī of Jodhò[2] and the influence exerted by her during her husband's life-time was in no way diminished after her husband's death.[3] That she was an energetic woman and took an active part in political events, may be gathered from the Bikaner Chronicles' account of how she went to negotiate with Vīkò under the walls of Jodhpur, when he was besieging this city.[4] Those were the times when female intrigues and favouritisms could in a moment alter that regular procedure which from time immemorial had been followed in regard to succession, and that even the nobles could be influenced by the virtues or craftiness of a particular rāṇī to bestow the *ṭīkò* of succession on a son of hers and deprive of his rights the legitimate successor, when the latter's mother was not in favour with them, is confirmed by the Jodhpur Chronicles' account of what happened at the death of Sūjò. It appears that Sūjò, during his reign, had appointed to succeed him his son Vāghò, who eventually died before him, leaving, among others, two sons by different mothers: Vīrama De, and Gā̃gò. Vīrama De was elder to Gā̃gò, but after Sūjò's demise (Saṃvat 1572[5]), the nobles excluded him from the *gaddī* because they disliked his mother, and elected Gā̃gò, whose mother happened to be agreeable to them.[6]

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[1] The other rāṇīs were: the Hulaṇī Jamunā De, mother of Jogò and Bhāra Mala; the Bhaṭiyāṇī Pūrā̃, mother of Karama Sī, Kū̃pò, Cā̃da Rāvȧ, Jasavanta, Rāī Pāḷa, and Vaṇa Vīra; and the Vāghelī Vīnā De, mother of Sā̃vata Sī and Siva Rāja.

[2] हाडीजी नूँ राणीपदौ थौ (*C.* **52**, p. 27*a*). In an adespotic *kavitta* in honour of rāva Jodhò contained in MS. **8** (*D.C.*, ii, i), p. 205*a*, Jodhò is given the epithet of जसमादेयवर, "husband of Jasamā De." This might be taken to indicate a privileged position of the Hāḍī rāṇī in comparison with her co-wives, but on the next leaf of the same MS. (pp. 206*b*—207*a*) we find a *gīta* by Bāraṭha Còhatha, also in honour of rāva Jodhò, where Jodhò is called नौरङ्गदेवर "husband of Nòraṅga De," the last-mentioned name being that of the Sā̃khalī rāṇī, mother of Vīkò.

[3] Incidentally, it may cause surprise that Jasamā De did not immolate herself on the pyre of rāva Jodhò. But in the Chronicles which I have seen, there is no mention of any rāṇī of Jodhò having become *satī* after him.

[4] Cfr. also the statement by some of the Jodhpur Chronicles, that it was Jasamā De who persuaded Narò to abdicate in favour of Sūjò.

[5] *C.* **39**, p. 20*a*; *C.* **68**, p. 7*a*; *C.* **52**, p. 33*b*.

[6] *C.* **52**, p. 36*a-b*; *C.* **39**, p. 20*b*. Similar instances of infringement of the rule of primogeniture are by no means uncommon in the annals of

From the cumulative evidence of the facts considered above it would therefore seem that rāva Vīkò, the founder of Bikaner, was elder than rāva Sūjò, the progenitor of the Jodhā Rāṭhòṛas who for over four centuries have been sitting on the *gaddī* of Jodhpur. Consequently, the ruling family of Bikaner is justified in its claim of seniority in respect to the ruling family of Jodhpur. Needless to say, the solution of the question of seniority in favour of Bikaner, has merely an ideal value, and does in no way affect the existing relations between the two States, nor detract from or add to the prestige of their respective Rulers. For if Sūjò was not the legitimate heir of Sātala by right of birth, he was the legitimate heir by election, and we have seen that, in the case of Marwar, the assembly of the nobles had the power to set aside the law of primogeniture and legalize the succession of a younger son. Therefore the election of Sūjò was perfectly legal. But Vīkò, to all appearances, was elder than him.

The problem which I have tried to solve in the above pages, would have never required such a long discussion if the Chronicles had preserved to us the accurate dates of birth of Vīkò and Sūjò. Unfortunately, these dates have been altered both by the Bikaner Chronicles and by the Chronicles of Jodhpur, each of the two sides wishing to represent the progenitor of its ruling family as senior to the progenitor of the ruling family of the other State. Thus the great majority of the Jodhpur Chronicles give Saṃvat 1497 as the year of the birth of Vīkò, and Saṃvat 1496 as the year of the birth of Sūjò, making the latter elder by only one year, just what was sufficient for their purpose. To counteract their measure, Dayāḷa Dāsa, the latest chronicler of Bikaner, has been forced to place the birth of Vīkò in Saṃvat 1495, just one year earlier

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Rajputana, and there is no doubt that female intrigues and influences were at the bottom in most of these cases. The rôle of Kaikeyī in the *Rāmāyaṇa* was played many times by other crafty rāṇīs at the courts of Rajputana. Tradition says that a female had her share in fostering the hate which rājā Gaja Siṅgha of Jodhpur (Saṃvat 1676-94) conceived towards his eldest son Amara Siṅgha, a hate which he carried to the extent of excluding him from the succession and even banishing him from Jodhpur (*D. C.*, i, i, 5, pp. 29*a* ff.). Another similar drama had been enacted at Jesalmer about three centuries earlier, when rāvaḷa Kehara had banished his eldest son Kelhaṇa and nominated to be his successor Lakhamaṇa, a younger son. In Bikaner itself we find rājā Rāi Siṅgha (Saṃvat 1630-68 ?) designate heir-apparent a younger son, from affection to his mother. That cases in which the right of primogeniture was set aside, were more frequent at the courts of the Rāṭhòṛas than elsewhere, has been remarked even by Muhammadan historians: "The customs of the Rāṭhòṛas are different from those of other Rajputs for that child succeeds whose mother the father has loved most, though he may be the younger . . . . [From the above-mentioned family custom] it happened that on the death of Udè Siṅgha, Sūraja Siṅgha, though he was younger than his brothers, succeeded to the title of Rajah . . . . " (*Maaṣiru-l-umarā*, transl. by Beveridge, pp. 571-2).

than the date which the Jodhpur Chronicles give for the birth of Sūjò. Taking it for granted that the Jodhpur chroniclers would alter only the date of Sūjò, the date Saṃvat 1497 which they give for Vīkò is probably the correct one. The correct date of Sūjò might have been preserved in the Bikaner Chronicles, but unfortunately none of the Bikaner Chronicles examined by me gives any date for the birth of this prince. In a Chronicle of Jodhpur,[1] however, I have found for Sūjò a date different from the one given by the other Chronicles, and this might possibly be the correct date. It is Saṃvat 1499. If this date is correct, Vīkò was elder than Sūjò by about two years.[2]

L. P. TESSITORI.

Bikaner, 25th April, 1918.

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[1] *C.* **39**, p. 20*a*.

[2] Though arguments of this kind are often worthless and even fallacious, yet the fact that Sūjò outlived Vīkò by several years, may have some significance as corroborative evidence in favour of Vīkò's eldership. Both Vīkò and Sūjò died a natural death.

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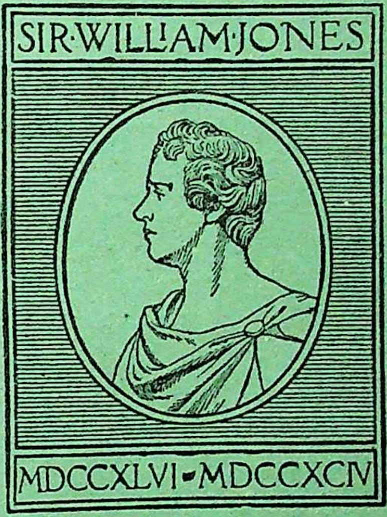
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3. Suggestions concerning the History of the Drainage of Northern India, arising out of a Study of the Siwalik Boulder Conglomerate.

By GUY E. PILGRIM, D.SC., F.G.S., *Assistant Superintendent, Geological Survey of India.*[1]

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(With Plates I–II.)

At the summit of the Siwalik series in India occur a set of conglomerate beds, containing, in many places, pebbles of such a size as to merit the name of boulders. They vary considerably both in composition and thickness, shading off occasionally into mere pebble beds and being anything from 5,000 feet down to one or two feet thick, but they invariably form the highest member of the series and can hardly be mistaken for any other beds that occur at a lower horizon in the series, where pebbles are merely of sporadic occurrence.

From the fact of their occupying such a constant position in the series and being of such nearly general distribution wherever the Upper Siwaliks were deposited, the writer[2] has termed the particular horizon on which they occur the Boulder Conglomerate Zone.

The existence of these boulder conglomerates has been mentioned by every geologist who has worked in the Sub-Himalayan tracts, but their presence would seem to have been regarded quite as a matter of course, both by those who have actually observed them and naturally by those who have only read the account of others' observations, and, therefore, have found it difficult to appreciate the peculiar occurrence and character of the beds in question.

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[1] This paper was written in January 1917. The author was then on military service in Mesopotamia, and without any access to books of reference. It was originally his intention to elaborate it on his return to India. This did not occur until 1919. In the meanwhile Dr. E. H. Pascoe had independently written a paper, which, as the author learns, though he has never seen it, embodies the same general conclusion as the one now published. Since Dr. Pascoe appears to have worked out the question very fully, it seems needless for the author to attempt any more than he has already done. With the exception, therefore, of a few necessary corrections and the addition of some explanatory details, the paper is published in much the same form as that in which it was originally written.

[2] G. E. Pilgrim, Correlation of the Siwaliks with mammal horizons of Europe. *Rec. Geol. Surv., India.* XLIII (1913), p. 324.

The writer, who has, perhaps, had more opportunity than anyone else of observing these boulder conglomerates throughout India, is inclined to consider that the interest attaching to them is greater than that of any ordinary pebble bed or accumulation of boulders. Although their peculiarities have not hitherto escaped me, and while realizing that these features must have some special significance, I have not, up to now, found any adequate explanation of their formation or distribution. At last, however, I have hit upon one which seems so entirely to meet the facts of the case that I am inclined to think that, at all events in its broad outlines, it may commend itself to geologists generally.

Before proceeding further it is necessary to summarize the known facts regarding the composition and occurrence of the Siwalik boulder conglomerates and of their distribution in India.

The area in which these beds reach their maximum development is in the tract of country extending roughly from the Beas to the Chenab. Within these limits they make up a large proportion of the composition of the low hills bordering the plains, dipping inward at angles of 45° or more, and attaining a thickness of more than 5,000 feet. Thence they regularly reappear in the same stratigraphical position in each of the five or six successive folds that occur between the plains and the older rocks of Jammu, Chamba and the Dhauladhar range, diminishing little, if at all, in thickness, seeing that in the Ravi below Dalhousie they must be 5,000 feet thick. They are certainly uncomformable to the underlying portion of the Siwalik series, and the combined breadth of their outcrops is greater than is the case with any other of the Siwalik zones. In the area of their maximum development they are exposed over a tract of country more than 60 miles broad, measured across the strike, and the author is of opinion that this represents the actual width of their outcrop originally. They are folded up with the lower beds of the Upper Siwaliks which consist of coarse sandstones with abundant pebbles alternating with clays, with a distinct representative of the Middle Siwaliks and with the Lower Siwaliks or Nahans. It is almost certain that the Murrees are included in these folds, but between the Ravi and the Beas they are not exposed for the reason that the axis of folding dips regularly to the N.-W. and each of the folds marks also the position of a thrust-fault so that, although the upper beds are well exposed, the lower beds are seldom reached. In most cases nothing below the upper portion of the Nahans is visible, the fault then bringing in the boulder conglomerates again. When we cross the Beas the lower beds in the series have a more and more extensive outcrop, while, on the contrary, the Upper Siwaliks in all except the outer hills have been gradually denuded away, at all events by the time we reach

Kalka. The whole thickness of the Upper Siwaliks is, however, shown in the outer hills and it is evident that across the Beas the boulder conglomerates diminish in amount. On the Sutlej they are perhaps 3,000 feet and across the Jumna the actual boulder bed is hardly more than 2,000 feet thick. On the Ganges at Hardwar the boulder conglomerate is even less and begins to shade into the pebbly beds of the Upper Siwaliks.

Middlemiss[1] has described the Upper Siwalik conglomerate in the lower hills of Garhwal and Kumaun to the east of the Ganges, and has noted that the conglomerate and the sandstone appear to replace one another from one locality to another, their respective thicknesses varying inversely as one another.

The boulder conglomerate is recorded by Middlemiss as far east as the Nepal border, but as far as one can gather it appears to be considerably thinner than on the Ganges.

Mallet[2] mentions the presence of conglomerates in the Siwalik series of Sikkim, but pebbles would seem to be neither so large nor so abundant as they are to the west.

When we arrive at the corresponding series exposed at the foot of the Bhutan hills and described by the writer,[3] we find that, although boulder conglomerates exist, the line of demarcation between them and the sandstone beds which immediately underlie them is less marked, and often, all that we can say is that pebbles are far more abundant at the top of the formation than is the case lower down.

La Touche and Coggin Brown in their respective descriptions[4] of the Siwaliks of the Aka and the Abor hills make no mention of a conglomerate, from which we may conclude that it is absent.

J. M. Maclaren has demonstrated the absence not only of the conglomerate[5] but of the whole Siwalik series in the neighbourhood of Brahmakund, and generally in the hills which hem in the upper portion of the Brahmaputra valley.

Proceeding in the other direction, while the boulder conglomerate continues with undiminished strength through Jammu, we find that it suddenly disappears across the Chenab. We may deduce this from some remarks made by W. Theobald in his paper on the Siwaliks.[1] The writer has not actually seen them die away, but in the Kharian hills on the eastern side of the Jhelam the highest bed of the Siwaliks is a loosely compacted sand, and below this the beds are merely coarse grits, with occasional pebbles. Equally across the Jhelam the uppermost beds of the series die down into the plains at the end of the Tilla ridge and are merely pebbly. Going west towards Pind Dadan Khan, a well-marked boulder bed exists at Jalalpur but it is less than 10 feet thick. On the northern flanks of Tilla the boulder conglomerates again come in and are some 200 feet thick. They are found of an equal thickness in various places throughout the country north of the Salt Range as far as or beyond the Indus, as for example at Domeli on the south of the Bakrala ridge, at Bhon, Nawal and in particular at Makhad on the Indus, where they are probably as much as 500 feet thick. At the latter place the dip is probably slight, and, therefore, the conglomerates cover a greater surface area than they would otherwise, but probably in former times they extended over most of the country north of the Salt Range between the Tilla Range and the Indus. In the direction of Rawal Pindi and the Murree hills the Upper Siwaliks are not found at all, consequently no boulder conglomerates exist.

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[1] C. S. Middlemiss, Physical Geology of the Sub-Himalaya between Garhwal and Kumaun. *Mem. Geol. Surv., India*, XXIV, 2 (1890), pp. 24, 28.

[2] F. R. Mallet, The geology of the Darjiling district and the Western Duars. *Mem. Geol. Surv., India*, XI, 1 (1874), p. 50.

[3] G. E. Pilgrim, Notes on the geology of a portion of Bhutan. *Rec. Geol. Surv., India*, XXXIV (1906), p. 23.

[4] T. D. La Touche, Notes on the geology of the Aka hills. *Rec. Geol. Surv., India*, XVIII (1885), p. 122. J. Coggin Brown, A geological Reconnaissance through the Dihong valley, being the geological results of the Abor expedition. *Rec. Geol. Surv., India*, XLII (1912), p. 236.

[5] J. M. Maclaren, Geology of Upper Assam. *Rec. Geol. Surv., India*, XXXI (1904), p. 193.

South of the Salt Range the boulder conglomerates are probably less well developed. They were found by La Touche[2] in the Sherani hills near Dera Ismail Khan. In the Bugti and Mari hills of Baluchistan boulder conglomerates occur[3] to a thickness of some 300 or 400 feet and in the neighbourhood of Quetta this is still further increased. Round the Manchhar lake in Sind there is an extensive outcrop of the Upper Siwalik boulder conglomerate.[4] Its thickness here is probably less than 100 feet, but the beds are nearly horizontal and so boulders strew the ground over a very considerable area. In Perim Island, Kachh, and Katthiawar the Upper Siwaliks, if such exist, are not noticeably pebbly.

In Burma beds of Upper Siwalik age are, so far as I know, absent. There are no particular conglomerates recorded, except in the so-called Red Beds of pontian age at the base of the Irawaddy series.

To sum up then, the Siwalik boulder conglomerate was laid down over a wide extent of country and accumulated to a colossal thickness in Jammu and Kangra between the Chenab and the Beas rivers. Going westward it thins out rapidly, but is again developed to some extent north of the Salt Range, again dies out southward but repeats itself in Baluchistan and Sind. To the east of the Beas it thins out slowly and probably a feeble representative of it is found as far east as Bhutan. On the accompanying map, Plate II, Fig. 2, representing the geography of India in the lowest Pleistocene, the approximate position of the Upper Siwalik zone is indicated by a continuous thick line, while the dotted area marks the occurrence of boulder conglomerates.

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[1] W Theobald, The Siwalik group of the Sub-Himalayan region. *Rec. Geol. Surv., India*, XIV (1881), p. 93.

[2] T. D. La Touche, Geology of the Sherani hills. *Rec. Geol. Surv., India*, XXVI (1893), p. 90.

[3] G. E. Pilgrim, The Tertiary and Post-tertiary deposits of Baluchistan and Sind. *Rec. Geol. Surv., India*, XXXVII (1909), p. 164.

[4] W. T. Blanford, Geology of Western Sind. *Mem. Geol. Surv., India*, XVII, 1 (1879), p. 58.

The boulders attain their greatest size in the area of maximum development of the bed, the largest being about 4 feet in diameter. The greater portion of the rock is made up of pebbles about the size of man's head, though in places the size diminishes to that of an orange. Smaller pebbles than this are not frequent, though there is a certain amount of sand and clay which helps to bind the whole together. As a general rule they are well rounded.

The greater number of the boulders are of quartzite but quite a number of slate and vein quartz occur and locally we find them composed of granite, trap rock, limestone, as well as of the Lower Siwalik sandstone.

The age of the uppermost beds of the Siwalik series are dated with a fair amount of accuracy by the first occurrence in them of *Camelus*, probably a migrant from Central Asia. In North America the earliest beds in which this genus has been found have been referred to the lowest Pleistocene. The writer[1] has placed the whole Siwalik series into the Pliocene, in which case the *Camelus* beds of North America should perhaps be slightly antedated. He is now inclined to think, however, that the topmost beds of the Siwaliks are contemporaneous with the lowest Pleistocene of Europe, which is the opinion expressed by Lydekker[2] thirty years ago.

It is generally agreed that no portion of the Siwalik series was contemporaneous with the so-called older alluvium of the Narbada, Godavari and Ganges, and, so long as an unconformability between these two sets of beds is recognized, it seems a matter of little moment whether we consider that the Siwalik era ended with the Pliocene, or was continued into the Pleistocene.

The formation of a boulder bed of the kind that has been described may be due to various causes.

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[1] G. E. Pilgrim, Correlation of the Siwaliks with mammal horizons of Europe. *Rec. Geol. Surv., India*, XLIII (1913), p. 325.

[2] R. Lydekker, Indian Tertiary and Post-tertiary vertebrate fauna. *Pal. Ind.*, series 10, Vol. II, p. 96.

(1) The first agency to which boulder beds often owe their origin is that of ice in a way which need not be described. Old moraines which testify to the increased cold of the glacial period in India have been observed in many places in the Himalayas [1] at elevations as low as 5,000 feet above sea level, but not only do they belong to a later period than the Siwalik boulder conglomerate zone, but also such moraines could produce no more than the merest fraction of the material accumulated in these conglomerates. Nor can an ice sheet be called into action, for we know that, even supposing that any portion of the glacial period were contemporaneous with the formation of the deposit we are considering, which is improbable, the low temperature requisite for the production of such an ice sheet could not have extended so far south as India. Finally the pebbles in the Siwalik boulder conglomerates bear no striations, facets or other characteristic traces of a glacial origin.

(2) In the neighbourhood of hills there is always a considerable amount of material detached from the hill slopes. Where the fallen pieces are remote from the streams they get shifted but slightly, are consequently but little water-worn and accumulate at the base of the hills where they fall. In the streams they get more water-worn and are shifted to a greater extent, some of them getting carried down eventually to the main channel of drainage while others are raised by floods out of the reach of the ordinary action of the stream and add to the accumulations which have taken place *in situ*. Such collections of boulders have been formed in several places all along the foot of the Himalayas. But whether they be mounds, hills or even ridges, they are not continuous and could not have extended over such wide areas nor assumed such vast dimensions as would make it feasible to ascribe to them the origin of the Siwalik boulder conglomerates.

The remainder of the boulders get carried along in the beds of the big rivers and are visible in the empty channels of all Indian rivers that dry up out of the rainy season. In the case of an ordinary river with a regular gradient they do not form a part of the deposit which is spread over the alluvial plains at flood times. Such pebbles can only enter into the formation of the alluvium if the river chances to desert its bed and take a new course, when the pebbles which form the floor of the bed at that particular spot remain as a lenticular patch of conglomerate which is covered up by ordinary alluvial silt during subsequent annual floods.

The boulders during their progress down the river gradually get broken up into smaller and smaller fragments and eventually these and the resulting detritus either reach the sea, or form material fine enough to be deposited on the land by the river when in flood, so that in a river with a regular gradient the boulders do not accumulate beyond a certain limit.

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[1] Hooker, Himalayan Journals, II, p. 7. Macmahon, *Rec. Geol. Surv., Ind.*, XIV, p. 310, XV, p. 49. Godwin Austen, *J.A.S.B.*, XLIV, pt. 2, p. 200. Blanford, *Manual of the Geol. of Ind.*, 1st Ed., pt. 1, p. 372.

For a precisely similar reason to which the mounds at the foot of the hills owe their origin, the basal bed of a continental formation is generally a conglomerate because it represents fragments that have become detached from a surface that is freshly exposed to denudation without being furnished with adequate drainage. Consequently a collection of boulders is formed, which may be widespread but is covered up as soon as rivers begin to flood their banks and deposit ordinary fine sediment.

Medlicott's suggestion,[1] endorsed by Middlemiss,[2] that these beds were formed by rivers debouching from the hills in the same position as they do now, founded on his observation that the boulders show signs of being more numerous in the vicinity of these rivers than elsewhere, is no doubt true so far as it goes. At the same time the boulder conglomerates are very far from being limited to such areas, and though Medlicott's theory may partly explain why the boulders vary in quantity from place to place, yet such an explanation is insufficient to account for the boulder conglomerates reaching such enormous thicknesses in areas remote from the modern Himalayan rivers.

Equally true may have been La Touche's suggestion that excessive rainfall and increased erosion are largely responsible for the pebble beds that were accumulated in Pleistocene times. The deposit with which he has specially dealt in this connection is the old red alluvium of the Madhupur jungles.[3] It may well be that the glacial period in India was heralded by one of phenomenal rainfall, and under such conditions an increased number of boulders would be brought down from the hills and would be carried further afield, but to anyone who has seen these Siwalik conglomerates it will, I think, be obvious that, with the utmost allowance for increased precipitation at the beginning of the Pleistocene, no river similar to those of modern India could have given rise to the beds we are discussing. Not only were they formed, for the most part, too far from the hills and over too wide an area, but there also seems no reason why the boulder bed should not be as well developed everywhere in the Himalayas as in Kangra and Jammu.

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[1] H. Medlicott, On the structure and relations of the southern portion of the Himalayan ranges between the rivers Ganges and Ravi. *Mem. Geol. Surv., India*, III, 2 (1864), pp. 119, 135.

[2] C. S. Middlemiss, *l.c.*, p. 24.

[3] T. D. La Touche, Relics of the great Ice Age in the plains of Northern India. *Geol. Mag.*, Dec. 5, VII (1910), p. 193.

The best testimony to the inefficacy of a river with a regular gradient to deposit the Siwalik boulder beds exists in the absolute failure of the modern Ganges and Brahmaputra to produce anything of the kind, and also of the Irrawaddy during the Miocene and Pliocene to accumulate any pebble beds in its deposits. Moreover the almost entire absence of pebbles in the lower portions of the freshwater series of India and their scarcity except in the uppermost beds of the series is not explicable except by invoking some factor which was not in operation previously to the epoch of the boulder zone.

(3) There is, however, one well-known cause which is responsible for the formation of pebble beds where none had previously existed. If any portion of the channel of a river is elevated, the depression produced behind this fold becomes a basin of deposition; the deposit will continue, other things being equal, until the basin is filled up and the regular downward gradient of the river is restored. If this basin has been produced near a hilly country, where large boulders are often being detached, a series of conglomerates will be deposited. Vredenburg[1] has pointed out how a slight earth movement in the Peninsula during the Pleistocene produced basins in the upper courses of the Narbada and Godavari as a result of which over 500 feet of sediment were laid down over a considerable area. In this deposit are many pebbles, but, on account of the remoteness of the hills, no boulder beds were formed. When these sediments had filled up their basins, the rivers recovered their former gradients and ceased to deposit, while at a still later date they cut into the gravels which had been laid down in the Pleistocene.

This is almost precisely what seems to have happened, only on a much larger scale and complicated by intense folding, in the Siwaliks. Sedimentation appears to have taken place in a broad river valley, into which tributaries entered from the north, occupying much the same position as the modern Himalayan rivers. A basin may have been produced by earth movement in such a valley, and in that case over its entire extent the materials of denudation contributed by the various affluents would accumulate. It may be that during the lower Pleistocene, on account of excessive rainfall, the debris which these tributaries brought down was largely increased in quantity as La Touche has suggested. It is also probable that the fragments would increase in size and in amount the nearer one approached the streams which drained the hilly area, according to the observations of Medlicott and Middlemiss.

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[1] E. Vredenburg, Pleistocene movement as indicated by irregularities of gradient of the Narbada and other rivers in the Indian Peninsula. *Rec. Geol. Surv., India*, XXXIII, pp. 33-45 (1906).

To complete the explanation of the facts, it remains to consider the question as to where the main river flowed, which carried all these hill affluents to the sea, why in any part of its course it was dammed back on such a huge scale, and how the barrage was continued for such a prolonged period as to account for the vast thicknesses of boulder conglomerate which according to hypothesis were thus formed.

Each of these will, to my mind, admit of but one answer, so far as concerns the main issues involved. During the periods which succeeded the Eocene it is a matter of common knowledge that important elevatory movements in regions directly adjacent to the Siwalik boulder conglomerate between the Chenab and the Ganges are confined to that tract of country which lies to the north and north-west of the outcrops in question. We cannot invoke any elevation on such an enormous scale and of such duration in any part of the country lying to the south and south-east of the conglomeratic area. Bengal, the United Provinces and parts of the Punjab formed with the remainder of the Indian peninsula a portion of the ancient continent of Gondwanaland. The remnants of ancient gneiss, which are exposed along the course of the Brahmaputra between Gauhati and Dibrugarh, as well as the coal beds of Gondwana age which occur in the lower hills along the edge of the Eastern Himalayas, indicate the extension of this land surface in a north-easterly direction. That subsidence may have taken place here is probable but not the reverse. Even supposing, for the sake of argument, that a movement of elevation in this southern area were at all feasible, and that a basin of deposition had been formed by a ridge stretching across the present alluvial area of Bengal, one would expect that the conglomerate deposited in such a basin would thicken as it approached the hypothetical ridge, but as a matter of fact we find the reverse of this to be the case. It follows that the dam must have been formed to the north or north-west of the conglomerate outcrop, and that the river which was thus dammed back, and to which we owe the whole of the Tertiary freshwater deposits of Northern India, flowed from south-east to north-west through a broad valley bounded on the south by the ancient, probably much denuded and not very elevated land surface embracing Bengal, the United Provinces and part of the Punjab, and on the north by the recently elevated and probably abrupt slopes of the Himalayas.

While the whole of the Himalayan area since the Eocene had been undergoing elevation, two portions of it may be singled out as presenting special features which distinguish them from the rest. One of these is the north-eastern angle, which is believed to have been elevated first and the other, the north-western angle, embracing Kashmir, the Murree hills and to a smaller extent the Simla hill states, where elevation, less at the commencement, has been most considerable during the later Tertiary periods. This is indicated by the wide distribution within this area of marine rocks of Eocene age and by the great elevations at which these rocks as well as the freshwater Murree beds now occur. Thus, the latter are found at elevations of more than 8,000 feet or 2,000 feet higher than the same beds occur elsewhere in the Himalayas. The faulted and exceedingly complex structure in the hills separating Murree from the plains—much more marked than in most other parts of the newer Tertiary area—is also a proof that here the earth stresses producing elevation were more intense than elsewhere. This difference in the behaviour of these two regions under the tangential pressures at work—a belief well grounded and based on widely observed facts—affords an explanation of how a north-westerly flowing river might have been dammed back in such a way as to produce the Siwalik boulder conglomerate and incidentally accounts for the character and distribution of each individual member of the whole Tertiary fluviatile series. It does not seem to the writer that the whole of the facts are susceptible of explanation on any other hypothesis.

I imagine no one will seriously dispute the proposition that the drainage of a considerable portion of India, when it formed part of Gondwanaland, must have been northward and large rivers flowing in this direction must have poured their contents into the Permian, Trias, Jurassic, Cretaceous and Eocene seas which successively rolled over the north-western portion of India and the Himalayas. A glance at the map, Plate I, Fig. 1, in which a reconstruction of the geographical conditions towards the end of the Eocene is attempted, will be sufficient to show how much more probable it is that the drainage of the northern half of India should be in a north-westerly direction than in any other.

If so much is admitted, it follows that between the end of the Eocene and recent times the drainage of that part of India must have been reversed. Opinions will only differ as to when and how this took place. With the elevation of the Himalayas and the withdrawal of the sea to the north, the geographical conditions being as shown in plate II, fig. 2, either one of three things must happen to a north-westerly flowing river—

(1) If the rate of elevation was sufficiently gradual and the erosive power of the river sufficiently great, the river would cut through the land as it rose from the sea, and, so to speak, follow the retreating sea through the mountainous tract, which would rise on either side of it.

(2) If the rate of elevation was too rapid for the erosive power of the river to keep pace with it, the latter might be elbowed off to the west.

(3) If the elevation was very sudden and the sea were accessible in another direction, the course of the river might be altogether reversed.

Whether the first of these results could have been noticed during the early stages of the elevation of the Himalayas or even in the Miocene is matter for conjecture, but in any case one cannot conceive it operating for long or there would still be a great north-westerly flowing river.

The writer is of opinion that the third of these results did not happen until after the deposition of the boulder beds in the Pleistocene, for, not otherwise than by the train of circumstances initiated by the second of the three alternatives, can the writer account for the formation of the boulder conglomerates. The reversal of the drainage concluded the Siwalik epoch and inaugurated modern conditions.

It is essential for the validity of the whole theory that it should account not only for the existence of the boulder conglomerates, but also for the special features and distribution of the whole series of Siwalik deposits which preceded them. I, therefore, propose to suggest how the distribution of the Siwalik boulder conglomerates may be explained on the hypothesis in question, and how the whole fluviatile series falls into its proper place in the continuons working of the same evolutionary scheme.

Before doing this it will be as well to give as brief a summary as possible of what we know about the character and distribution of the different members of the series.

In India no Tertiary river deposits anterior to the Aquitanian or the lowest Miocene are known, but in Burma the Pondaung sandstones represent a fluviatile deposit of the upper Eocene, affording one of many pieces of evidence that the uplift in this part of India preceded that of the Central and N.-W. Himalayas.

In the Aquitanian or lowest Burdigalian period a limestone conglomerate with rolled pebbles of Nummulitic limestone and associated shales, often gypsiferous, was deposited in the Murree and Kala Chitta hills between Rawal Pindi and the Indus. This probably represents a series of lake deposits. To approximately the same period belong the coarse grits, containing numerous ferruginous concretionary masses, of the Bugti hills of Baluchistan, also largely lacustrine in origin. Of a similar age are possibly the basal beds of the Dagshai series consisting of ferruginous and gypsiferous clays somewhat concretionary in character.

The deposits of the Murree beds, consisting of fine-grained, dark-grey or purple sandstones, belong to the Burdigalian and Helvetian periods. These attain a maximum thickness of some 8,000 feet in the Murree hills but, while retaining the same character, diminish in thickness towards the S.-E., being reduced to 1,000 feet or so on the Jumma and barely represented on the Ganges. The topmost beds, known as the Kasauli stage, are found in various places between the Jhelam and the Jumna and are probably a lake deposit.

The Murree beds exist in the Kala Chitta hills, where they are perhaps 2,000 feet thick, but they thin out going south towards the Salt Range, where they appear to be represented by finer-grained and more concretionary beds which are only of a trifling thickness. South of the Salt Range they die away entirely.

The Lower Siwaliks consist of a great thickness of sandstones, known as the Nahan series, probably reaching their maximum development of some 10,000 feet between the Sutlej and the Jumna, though there is little doubt that they formerly existed in probably equal amount to beyond the Ravi, but are concealed from view by faulting. Eastward they gradually die out, being less than 5,000 feet thick beyond the Ganges, while it is doubtful whether they extend beyond the eastern border of Nepal. East of the Teesta the Siwalik series with a total thickness of 11,000 feet[1] partakes rather of the nature of the coarse-grained pebbly sandstone of the Upper Siwaliks.

The Lower Siwaliks are absent over the larger portion of the Murree hills but descending towards Rawal Pindi they overlie the margin of the Murree series.

As we go south to the Salt Range, they alter in character and consist largely of fine-grained, nodular and concretionary clays with interbedded sandstones belonging to the Kamlial and Chinji zones. They are some 4,000 feet thick here, and, beginning in the Tortonian, extend through the Sarmatian stage of the Upper Miocene. Their lithological character is partially continued in the Nagri beds of the lower Pontian. South of the Salt Range, beds of Lower Siwalik age occur in the Bugti hills and Sind, being in both localities of a concretionary character but coarser than in the Salt Range.

At the top of the Nahans some few hundred feet of beds were deposited of a lithological composition precisely similar to the Lower Siwaliks of the Salt Range. These are probably lower Pontian and belong to the Nagri horizon. They are developed throughout Kangra and the Simla hill states, being everywhere fossiliferous and especially so at Haritalyangar in the Bilaspur State.

The Middle Siwaliks which succeed them are coarse cream-coloured sandstones with occasional pebbles and a few interbedded clays, attaining a thickness of some 5,000 feet north of the Salt Range. They certainly occur in Jammu and on the Sutlej and no doubt in all intermediate areas but are much less thick and probably still further diminish going towards Nepal. In the absence of fossils it cannot be known with certainty how much of the Siwalik series eastward of the Ganges is Middle Siwalik, but in the writer's opinion little, if any, is of that age. Middle Siwaliks are represented in Sind and probably in the Bugti hills. Their presence elsewhere south of the Salt Range is only conjectural.

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[1] Mallet, *l.c.*, p. 47.

The Upper Siwaliks, consisting of pale-coloured, coarse-grained sandstones, with abundant but scattered pebbles attain their maximum thickness between the Chenab and the Sutlej, where it may amount to as much as 15,000 feet. Beyond the eastward border of Nepal it seems exceedingly likely that nearly the whole of the Siwalik series belongs to this horizon. Here a thickness of some 11,000 feet is probably within the mark, and it can be little less in the Abor hills. They are less thick in the Salt Range where an average of 5,000 feet is fairly near the correct figure.

South of the Salt Range they are known to occur in various places, but I am unable to give actual figures of the thickness except in the Marri hills and Sind where 2,000 feet probably represents their total thickness.

I have already given an estimate as to how much of this from place to place consists of boulder-conglomerates.

In Burma, the Irawaddi series does not appear to have begun until the Middle Siwalik epoch. The writer has seen no clear evidence of the occurrence in it of Upper Siwalik fossils, though it is possible that strata of this age may exist in the lower portion of the Irawaddi valley. Pebbly and concretionary beds—so-called Red Beds—occur at its base and coarse sandstones and clays for the remainder. A few thin freshwater horizons occur at lower levels interbedded with marine or estuarine beds of the Pegu series.

The Siwaliks of Cutch and Katthiawar, including Perim Island, are, probably, largely Middle Siwalik and it is unlikely that much either of Lower or Upper Siwalik age is contained in them. They may be mere remnants of a much larger basin of deposit, now buried beneath the sea.

I shall now proceed to translate these facts into a connected history on the assumption of a great Siwalik river flowing westward and north-westward on which assumption alone, so far as the writer can see, can the character and distribution of the deposits be explained.

Such a river might in Eocene times have entered the sea somewhere near Subathu, following somewhat the same course as the modern Ganges and rising on a watershed, of which a portion may, doubtless, still be seen in the Rajmahal and

Hazaribagh ranges, and which there is every reason to believe was continuous across the modern stretch of Indo-Gangetic alluvium and joined the hills of ancient rock still exposed on the Shillong plateau and in the upper valley of the Brahmaputra, passing on into the old continent of China.

The uplift at the close of the Eocene must have been such as to divert this river through Jammu and into the Murree hills. At what period it ceased to enter the Oligocene sea to the north-west is unknown, but by lower Miocene times it must have joined the river flowing south through a valley situated west of the course of the modern Indus and draining the old tableland of Persia and Afghanistan which had existed in Eocene times. The accompanying maps (Pls. I–II) will explain this more clearly. In any case further gradual elevation throughout the Lower Miocene must have formed a basin of deposition in the Murree hills, and the diminution of deposit higher up the course of the river and also beyond the region of elevation is what we should expect. The greater uplift of the region W. and N.-W. of Rawal Pindi may be assumed to account for the considerable reduction of the deposit south-west of the Murree hills, and the simultaneous elevation of the Salt Range is the only reason why we should get any deposit at all in that area. South of the Salt Range sedimentation naturally ceased.

The material carried down by this great river must have been largely derived from the older ferruginous rocks of the Indian peninsula, for the uplift of the Eastern Himalayas may only have been sufficient to bring in a tributary flowing near and parallel to the course of the modern Brahmaputra through Assam, but the latter must, at this stage, have contributed but a minor portion of the sediment, while still less could have been brought down from the low and recently elevated land to the north. This will probably account for the difference in character between the Murree series and the succeeding deposits, their purple colour being due to the iron-containing rocks drained by the river. The absence of pebble beds is also explained by the remoteness of the basin of deposit from hilly country.

Further upheaval, more pronounced in the region of the Murree hills, again diverted the direction of the valley southward, and gradually damming back the channel of the river produced the Nahan sediments, which are naturally thicker near this line of folding and diminish in quantity with the river's more rapid rate of flow as they draw nearer to the rising country in the north-east angle of the Himalayas. The tributary, already referred to, which drained this country, must by now have become the main carrier of material and have increased in volume and rapidity, while, on the other hand, the older river which drained the Peninsula must have flowed more slowly and brought down less material. The character of the Nahan sediments bears witness to the probability of this supposition.

Southward of the dam the flow of the river must have become more normal, that is more rapid and so in spite of the still rising Salt Range the Lower Siwalik sediments of this area would be less in amount than, and differ in character from, the Nahans of the Himalayan area, which is actually the case. It is possible, as the writer has suggested elsewhere, that the sandstone bands of the Chinji beds interbedded with concretionary clays represent periods of flooding alternating with cessation therefrom in a river valley whose gradient was fairly constant and comparable to that of the modern Ganges and Brahmaputra. The successive changes would be due to variations in the rate of uplift both behind and in front of the depositing area.

At the close of the Lower Siwalik period, however, the Nahan sediments must have filled up their basin while the uplifting forces temporarily ceased. Consequently we find that for a brief period the conditions of deposit approximated in the Salt Range and the Himalayas as evidenced by the argillaceous and concretionary character of the beds which succeeded the Lower Siwaliks of the latter area at Haritalyangar and elsewhere and which are not to be distinguished from those of the Chinji and Nagri zones of the Salt Range.

In Middle Siwalik times the elevation of the Salt Range must have been more rapid to account for the greatly increased sedimentation in that area, which diminishes in amount as we go backward up the course of the river.

In the Pliocene further elevation of the Kashmir–Jammu area must have occurred to cause the accumulation of the vast Upper Siwalik deposits. The main river valley must now have coincided with the outcrop of the Upper Siwaliks, as shown on the map, in Pl. II, Fig. 2, completely dominating the old southern tributaries. At the same time the whole course of the river must have become flatter, with the result that Upper Siwalik sediments are met with all along its valley.

In the last stage of the Siwalik period the upheaving forces were intensified, and as a consequence of this the whole area embraced by Jammu and Kangra appears to have been practically turned into a large lake with an outlet on the western side. The numerous tributaries from the now lofty mountains on the north must have kept bringing down boulders, which the flow of the river was too slow to enable it to dispose of. They, therefore, must have accumulated to form a boulder deposit, generally distributed over the whole of the area in question, though varying in thickness from place to place. Only a minimum could have passed over the western edge and been available to contribute to the boulder conglomerates of the Salt Range. This was doubtless supplemented by the now increasing Indus, which drained both the country to the west of Murree and Hazara as well as a great portion of what is now the southern Panjab, probably still further augmented by the capture of the river which used to drain from Kashmir and Western Tibet into a northern Miocene sea. As the gradient of this river must necessarily have been regularly on the increase, it could only have been the elevation of the Salt Range, and further south that of the ranges of Balcuhistan and Sind, that caused the formation of any conglomerate at all in these regions.

A final uplift, on a more colossal scale than any that had preceded it, seems to have been chiefly instrumental in entirely reversing the direction of flow of the great Siwalik river, wnile at the same time it folded and faulted both the Upper Siwalik boulder conglomerates as well as the older river deposits. The drainage of that part of the Himalayas lying to the west of Simla flowed into the channels of the Chenab, the Ravi, the Beas and the Sutlej while that to the east of Simla flowed back by the long established channels of the Jumna, Ganges and other rivers into the Bay of Bengal, the two systems of drainage being separated by the hilly country of the Aravallis and Rajputana. The upper course of the Siwalik river turned abruptly south to form the modern Brahmaputra along another ancient channel. The way in which this may have been effected is discussed on pages 97—98.

An eloquent testimony to what happened at this period exists in the more or less well-marked **V**-shape which all these rivers assume along a certain definite portion of their course. The points of the **V**'s are in every case directed north-westward and lie roughly on the site of the boulder conglomerate, as may be clearly seen on the accompanying map (Pl. II). I can find no apparent reason for this abrupt change in direction of the present rivers except that the northern arms of the **V**'s represent tributaries flowing in the normal direction which they would take to join a great north-westerly flowing river, while the southern arms are either the normally flowing southern tributaries of such a river, or represent the direction which the water in the northern tributaries would naturally follow when the drainage was reversed. Thus ended the last episode of the long Siwalik drama.

A further question arises at this point as to how these Himalayan rivers, following the direction which, by hypothesis, they did, were able eventually to pour their water into the Bay of Bengal. This water on entering the old channels of the northerly flowing tributaries of the Siwalik river would encounter a gradient which, slight though it might have been, would oppose its passage. Moreover farther south would be presumably a drainage system for the old watershed,—a drainage system of which the general direction would be northward. It is, therefore, natural to ask how a way may have been opened through this obstruction. I am not aware of any facts which enable us to determine exactly how this was effected, and it must be understood that the explanation that follows is only suggested in order to carry the record down to the establishment of modern conditions.

At the present time in the tract of country embraced by Orissa this is the watershed of a river system which, though complicated, is of no great length, and largely centres in the delta of the Mahanadi. There seems to be no resemblance between the deposits of the Mahanadi and the Irawaddi in spite of the fact that the two rivers rise in what must have been, in Miocene and Pliocene times, one continuous watershed, and flow into the same ocean. While the Irawaddi furnishes us with a continuous series of estuarine and flood-plain deposits extending from the Eocene to the present day, the deltaic deposits of the Mahanadi are Sub-Recent and correspond in age only to those of the lower portion of the modern Irawaddi delta. The rise of the Arakan ranges seems hardly sufficient to account for the difference in the deposits of the two rivers. It, therefore, seems probable that the Eocene and Miocene fluviatile beds, which would correspond to those of Burma, lie beneath the ocean, and that in Miocene times, at any rate, the coast line was not far short of the Andamans, making the continent of India much larger than is the case to-day.

During the Cretaceous transgression the sea undoubtedly flowed in over portions of the ancient Gondwana continent and has left marine deposits along the eastern coast of Madras. Subsequently, however, it certainly disappeared from within the limits of the Indian peninsula and probably retired much farther east, restoring in great measure the former surface features of this part of Gondwanaland, perhaps as far east and south as the Nummulitic beds of the Andamans.

It seems, therefore, not unlikely that this area was submerged later than the Miocene and that in former times the Mahanadi drained a much more extensive tract of country than it does to-day, which perhaps one would infer both from its present width and its complicated system of tributaries, which are altogether disproportionate to its length as we see it at the present time (see Pls. I and II).

Similarly it is likely that the Miocene rivers, which may have occupied approximately the same channels as the lower portions of the modern Hugli, Ganges and Brahmaputra and which rose originally in the same watershed as the Mahanadi (now vanished from that area), were also powerful rivers and flowed into the sea a long way south of the point where their modern successors enter it to-day. A tilting of this region sufficient to submerge it during the Pliocene would have immensely increased the erosive power of these southerly flowing rivers. There is, therefore, some ground for supposing that even prior to the Pleistocene these rivers had cut back through the watershed and captured a considerable part of its northern drainage. Consequently, when the course of the north-westerly flowing river was reversed, it may have been a comparatively easy matter for the water to find its way into the Bay of Bengal by river valleys which were already in existence. This supposition seems more likely than that the watershed was depressed by local subsidence, or faulting, or that the reversed rivers were able by their own force to cut a way through the watershed to the sea.

It is evident that the Godavari and the Kistna have at some period cut back through crystalline rocks which may have formed an outlying portion of the same watershed, since they now rise in the Western Ghats.

Similarly the Brahmaputra may have cut back through it in another place and captured the headwaters of the old Siwalik river, either at the time when the reversal of drainage took place or even earlier than this.

We may suppose that the portion of the Siwalik river which drained Kangra and Jammu reached the Arabian sea in a somewhat similar fashion. Ever since the origin of the Indus its Punjab tributaries, the Jhelam, the Chenab, the Ravi, the Beas and the Sutlej, must have been cutting back towards the north-east, and by the Pleistocene may have captured a considerable portion of the drainage of the Siwalik river from off the Aravallis and Rajputana.

The Pleistocene pebbly gravels which have been found here and there on the margins of, or as islands in, the Gangetic alluvium, as for example at Allahabad and Sara, are doubtless the first deposits of the new southerly flowing rivers before they had regularly established themselves on their downward gradient to the Bay of Bengal. At a later stage this class of deposit ceased and was replaced by the modern annual accumulations of silt.

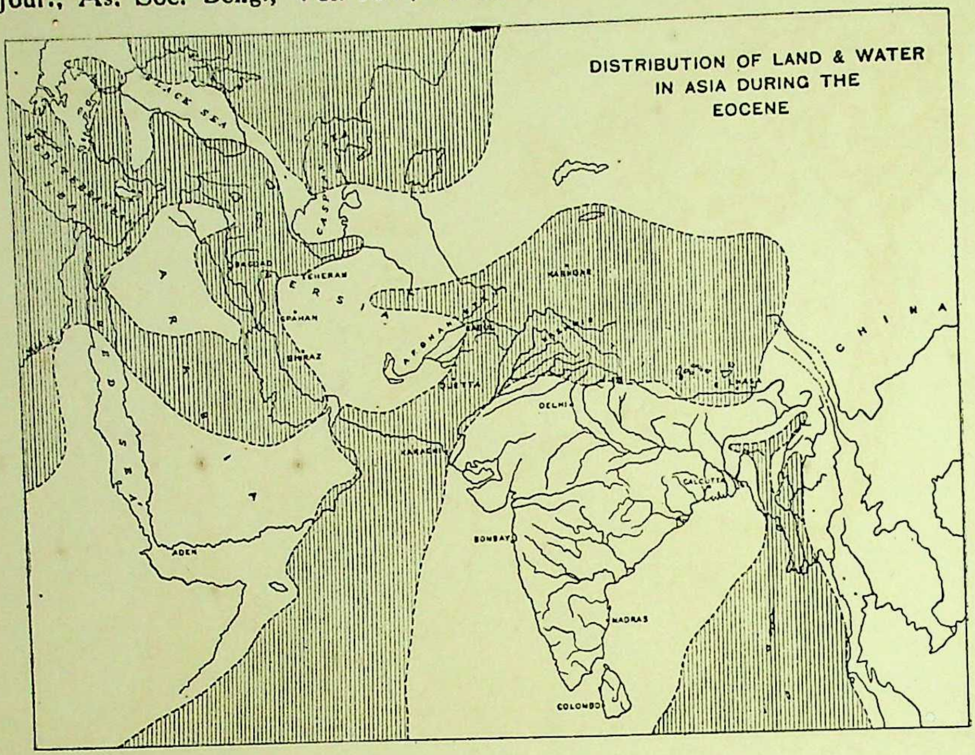
I must apologize for what may seem a rather dogmatic treatment of the history of these deposits, but I have thought that it would be clearer and more useful to suggest a single probable explanation for each one of the main observed facts than to deal judicially with all possible or impossible alternatives. I do not for a moment pretend that it is the only one or that it is correct in every particular. Facts yet unknown may alter the interpretation in details whether trifling or important, but the point on which I desire to lay stress is that the stratigraphy of the deposits is susceptible of explanation on the main general hypothesis, paying due regard to the information known or inferred which is at our disposal concerning the elevation of the Himalayas. On the other hand, so far at least as the writer can see, it cannot be explained on any hypothesis, which involves a system of drainage in Siwalik times essentially the same as that of to-day, without a serious violation of the observed or inferred data.

Summary.

The author considers that the peculiar character and distribution of the Pleistocene Boulder beds of the Siwalik series are capable of explanation only on the supposition that they were laid down in a rock basin formed in the valley of a large river by upheaval and the consequent formation of a dam across its course. Since in Jammu and Kangra these boulder beds attain the enormous thickness of 5,000 feet and disappear quite suddenly to the north-west of this area, while to the south-east they gradually diminish in thickness and are feebly represented as far as Bhutan, it follows that such a dam must have been situated north-west of Jammu and that the river flowed along the foot of the Himalayas from south-east to north-west. In Eocene times when sea covered the whole of the Western Himalayas such a river must have risen on a watershed connecting the Rajmahal hills to those of Shillong and the upper valley of the Brahmaputra, and continuing into China. A tributary of this river, draining the Eastern Himalayas, may at a later period have become the main river of Northern India. The author considers that the complicated drainage system and breadth of the Mahanadi so disproportionate to its length, as well as the entire absence of any fluviatile deposits older than Sub-Recent, such as we find on the Irawaddi, point to Pliocene submergence of much of its former valley and to a much wider extension of the Indian peninsula over what is now the Bay of Bengal from the Eocene onward, than is the case to-day. Therefore powerful rivers flowed south rising on the same watershed which is mentioned above. These may have cut back through it, so that when a final uplift on a more colossal scale than any that had preceded it actually reversed the flow of the river in the basin of which the boulder conglomerates were deposited, the water flowed into the channels of the southerly flowing rivers which were ready to receive it. The **V**-shape of many of the Himalayan rivers along a certain portion of their course (the point of the **V** facing north-west), is significant as evidence that the northern arms of the **V**s represent tributaries flowing in the normal direction which they would take to join a great north-westerly flowing river. The Gangetic alluvium, thick though it is, has all been deposited later than this period in the valley of rivers with a normal gradient as the result of annual floods, depression continuing simultaneously with the addition of flood material and sediments.

Jour., As. Soc. Beng., Vol. XV, 1919.

Plate I.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KARACHI
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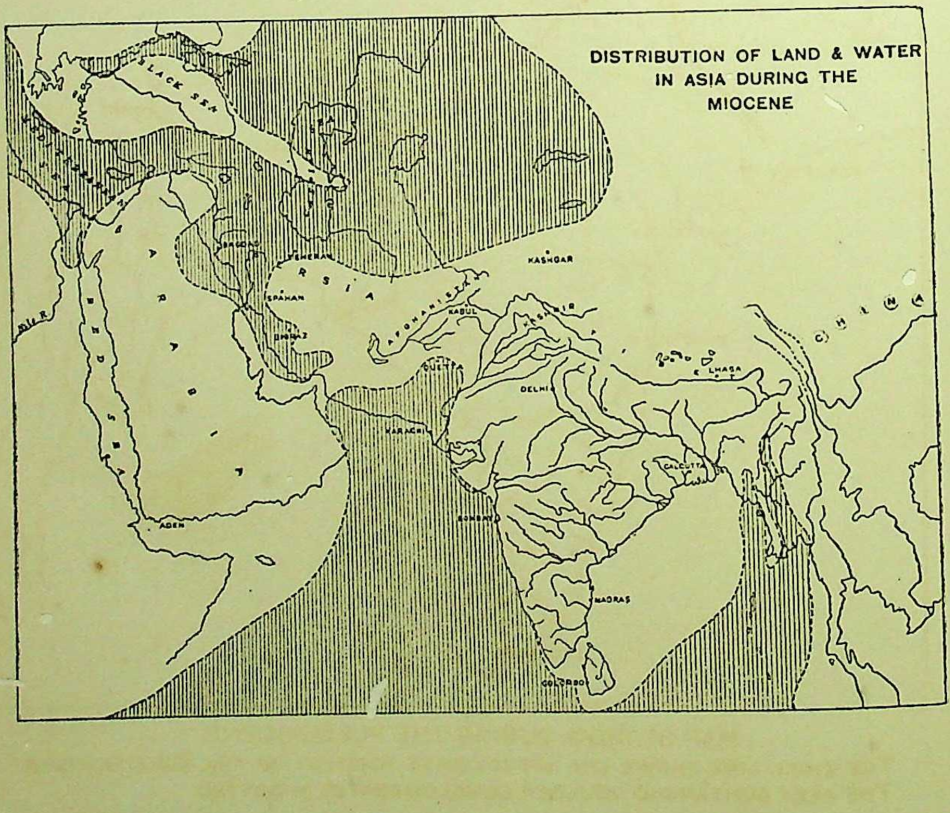
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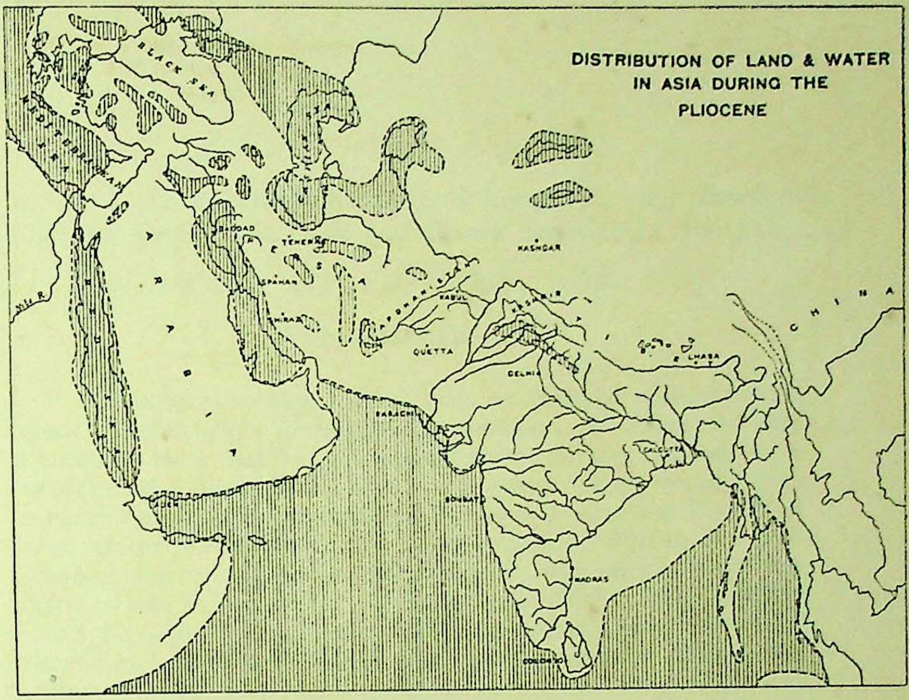
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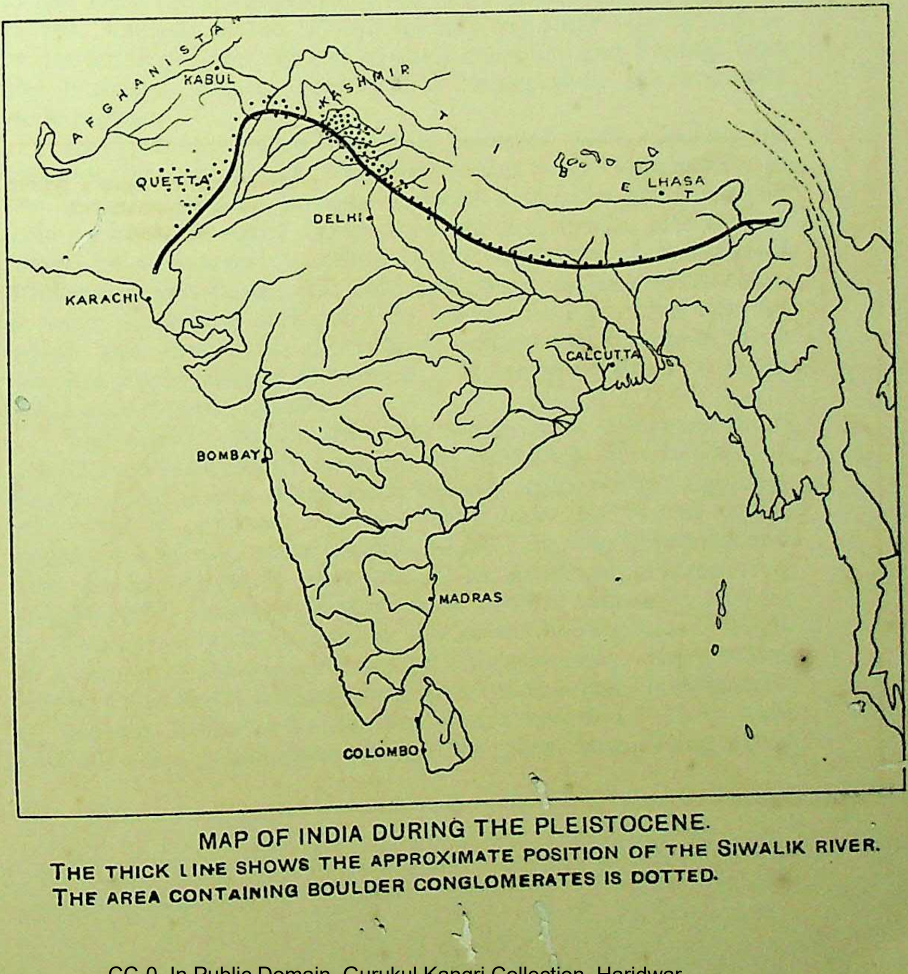

AFGHANISTAN
KABUL
KASHMIR
TIBET
QUETTA
DELHI
LHASA
KARACHI
CALCUTTA
BOMBAY
MADRAS
COLOMBO

MAP OF INDIA DURING THE PLEISTOCENE.
THE THICK LINE SHOWS THE APPROXIMATE POSITION OF THE SIWALIK RIVER.
THE AREA CONTAINING BOULDER CONGLOMERATES IS DOTTED.

4. A Note on the Vitality and Longevity of Silkworm Moths during the Cold and Rainy Seasons in Bengal.

By MAUDE L. CLEGHORN, F.L.S., F.E.S., F.Z.S.

(With Plates III—IV.)

For some time past I have been working on the improvement of silkworms in Bengal by selection for longevity and immunity from disease, but not till about three years ago were experiments able to be done on a large scale. When dealing with several hundreds of individuals in each generation I noticed that on the whole the moths lived very long during the cold seasons, fairly long in the hot weather, but only a very few days in the rainy season. This rise and fall in the vitality takes place every year, and I find on looking over old notes that it had also taken place when I was working on a small scale. I have also found when selecting for longevity that rejected moths, which are left unmated, always live much longer than the mated ones of the same generation. Silkworm moths, whether mated or not, usually lay their eggs a day or two after they have cut out of their cocoons, and I found that the unmated females usually live longer than the unmated male moths.

As my time is more than fully occupied with selecting for longevity and immunity from disease and with experiments in the invisible voltine (brood) characters, I have not yet been able to work at entire families of rejected moths although it would be of interest to compare the longevity of mated and unmated moths during the cold and rainy seasons when there is such a distinct difference in their vitality. The rate at which the long and short-lived moths use up their fatty reserves would also be of interest. However, I have to defer these experiments till later.

The family Bombycidae, to which the silkworm moth belongs, and the family Saturniidae, to which the well-known Emperor moth and Atlas moth belong, unlike other Lepidoptera, lack a proboscis; in fact they have no buccal orifice whatever and are quite unable to take in any nourishment. This characteristic is of value in experiments in longevity, and simplifies matters, as there is no need to take into account the amount of food consumed, the moths having to rely solely on their fatty reserves. Another characteristic, which makes silkworms in India well adapted for experimental investigation, is that the Indian varieties are many brooded. They have eight or nine generations during the year, completing about two generations in each season. They are also very prolific, as a moth usually lays about two hundred eggs.

During the cold season 1915-16 when I had only just begun working on a large scale and had many hundreds of moths from which to select, I found that great numbers in each group of families lived over eight days, so I decided to reject all those which lived under eight days. I continued my selection with regard to longevity through the hot weather of 1916, and although it was quite warm in May and June a very fair number of moths lived over a week. However, in the generation reared in July, the moths of which cut out of their cocoons in August, I was surprised to find that nearly all the moths were dead by the seventh day, and out of over two thousand individuals only two lived eight days. I expected the following generation, produced mainly from these short-lived moths, to be delicate; I found, however, that they did well, and on the whole the moths lived rather longer. On the approach of the cold weather many moths began to live well over eight days again, and in the generation reared in December 1916 and January 1917, many lived about twenty days. I watched this rise and fall in the vitality of the moths more closely through 1917 and found that it was repeated, for only a few moths lived over six days in August and September.

It is well known that all insects complete their larval and pupal stages quicker in the hot than in the cold weather; I am, however, not aware that the effect of the season on the length of the *imaginal* stages of insects has been recorded. It is well known that many beetles and cicadas live for years, but it is not generally known that moths, butterflies and mosquitos have quite a fair length of life. I have also found that butterflies kept in captivity live longer in the cold than in the rainy season. A specimen of *Hypolimnas bolina* which lived ninety-two days was caught on the 2nd November and died on the 1st February.

The four families chosen to show the rise and fall in vitality during the seasons, were selected because they are descended from long-lived moths. They are being continued up to date and are in their fifty-seventh generation.

The general results obtained in the ten generations from January 1917 to April 1918 have been represented diagramatically in Tables I, II, III, and IV. Diagrams I and II are of two families reared from March 1917 to April 1918, and Diagrams III and IV, which are of another branch of the same race, were reared from January 1917 to March 1918 and are also in their fifty-seventh generation.

In these diagrams the figures on the base line show the number of moths, and the vertical lines above the figures show the number of days the moths have lived. These upright lines must be referred to the column of figures on the left which gives the number of days. The length of the uprights are proportional to the number of days in the left column. The exact number of days the short-lived moths lived were not always noted as these moths are usually rejected. When the moths have lived *under* a certain number of days I have shown the uprights as broken. However, they are all known to be dead on the first day on which the longer-lived moths were noted as being alive.

It is apparent from a study of these diagrams, that there is always a pronounced rise in the vitality of the moths in the cold season and a fairly sudden drop in the rainy season. It is always lowest in either August or September, but in March, April, May and June it remains almost stationary, being neither high nor low. Diagram I shows a fairly regular rise and fall, highest in December, when many moths lived fourteen, fifteen, and seventeen days, and one ninteen days; lowest in August, when only six moths lived five days and the remaining eighty-four lived three days and under three days. In March, April, and June the vitality was fairly high, but in October it was lower than might have been expected. Diagram II shows a greater rise and fall than that which occurred in the vitality of the family represented in Diagram I. It was, as usual, highest in December, rising to twenty days, but the greatest drop was in September, not August, when it fell very low, none of the moths out of one hundred and fifty-eight living more than three days. In October the degree of vitality remained much the same as that shown in Diagram I.

The two families the longevity of which is represented in Diagrams III and IV are of the same race, but only distantly related to the two families represented in Diagrams I and II. Diagram III shows a regular rise and fall with the greatest drop in September. There is an unusual rise in April when one moth lived fifteen days, two fourteen days, and seven twelve days.

In Diagram III the rise and fall in the vitality seems very gradual, the rise is slightly higher than usual and the fall is not as low as shown in the other Diagrams. It is lower in August than in September as only one moth lived seven days in August, while seven lived seven days in September, seven lived six days, and fifteen lived five days, whereas only five lived six days and three lived five days in August.

The unusual rise in the August generation shown in Diagram III may probably be due to the greater longevity of the parent moths from which it is descended. In fact the families represented in Diagrams III and IV are from a much longer-lived branch of the race than that from which the families represented in Diagrams I and II are descended. In all the generations given in the Diagrams the length of days the maternal parents lived is indicated by an arrow. The paternal parents have not always been recorded as they have on the whole been short-lived. However, in the 49th generation in Diagram I both parents lived ten days, and in the 48th generation in Diagram III the paternal parent lived nine days and the maternal twelve days.

A glance at the Diagrams shows that the rise and fall in the vitality of the moths are not always connected with the duration of the larval and pupal stage, for the moths which emerged in January and February lived longest and had a larval and pupal stage of sixty-three days only, while those which emerged in March, after passing through a larval and pupal stage lasting eighty days, lived about the same number of days as those which emerged in May and June, which had a larval stage lasting forty and thirty-eight days respectively. From this it appears that if the moths cut out at the end of the cold weather they will not live very long, although they have had the benefit of the cold weather during their larval stage. In Diagrams III and IV the difference is quite apparent between the longevity of the moths which emerged at the end of January 1917, after a larval stage lasting seventy-six days, and those which cut out at the beginning of January 1918, after a larval stage of sixty-one days.

The effects of temperature and moisture on insects have been shown in a number of most carefully conducted experiments by Tower on beetles, and fully described in his valuable work "An Investigation of the Evolution in Chrysomelid Beetles of the Genus *Leptinotarsa.*" In his experiments Tower used the larvae of *Liptinotarsa decemlineata* and subjected many thousands of individuals to varying conditions through the larval and pupal stages till the adult insect emerged. As he gives the mortality percentages in each experiment, it is interesting to see how the various conditions to which the insects are subjected affected their vitality. As Tower's experiments were conducted to determine the effects of temperature and moisture upon the *colouration* of the beetles the results were taken after the beetles emerged, and not after their death, so the death-rate given was taken during the larval and pupal stage and not in the imaginal instar.

However, the mortality percentages are very interesting. In one of his experiments to determine the effects of a high average deviation of temperature on over ten thousand beetle larvae the death-rate was 99 per cent. In this experiment the average normal temperature was 22·403°C and the average temperature in the experiment was 34·5°C. This difference in the temperature (12·097°C) is about the same as that shown for January 1918 and May 1917 in the Diagrams.

In another experiment in which Tower subjected over six thousand beetle larvae to a large decrease in the average temperature, about 13·4°C below normal, the death-rate recorded was 95 per cent. The maximum temperature in the experiment was 15·5°C and the minimum was 6°C.

In his moisture experiments he showed that when there was a moderate increase in the relative humidity the death-rate was only 15 per cent but that it rose to 90 per cent in a saturated atmosphere, and that when there was a large increase in both temperature and moisture condition the mortality percentage rose to 95.

Tower's experiments show how harmful a high average deviation of temperature can be to insect life. They also show that a large decrease in the temperature is also harmful, but not quite as much.

In connection with this rise and fall of vitality in moths in relation to the seasons it is of interest to find that Birch. referring to statistics of soldiers' children in India, which afford full information of the relative healthiness of each month, states: "The most unhealthy months are, we see, July, August, and September—one-third of the total admissions and nearly one-third of the deaths then occurred; and December, January, and February are the healthiest months. A gradual rise to the beginning and fall from the end of the first-named period is marked by the figures with singular regularity. The increase of mortality and sickness is coincident with the advent of extreme heat and damp." The statistics he refers to show that the number of admissions into hospital in January was 440, while in August it was 1,360, and in September 1,024. The number of deaths for January was 41, for February 32, while in July it was 99, in August 155, and in September 99.

On the whole it seems very evident that the great heat and humidity to which most forms of life are subjected during the rainy season diminishes their vitality to a considerable extent. The dreaded month of May is somehow not so harmful as the Rains, which are looked forward to as a welcome break in the heat.

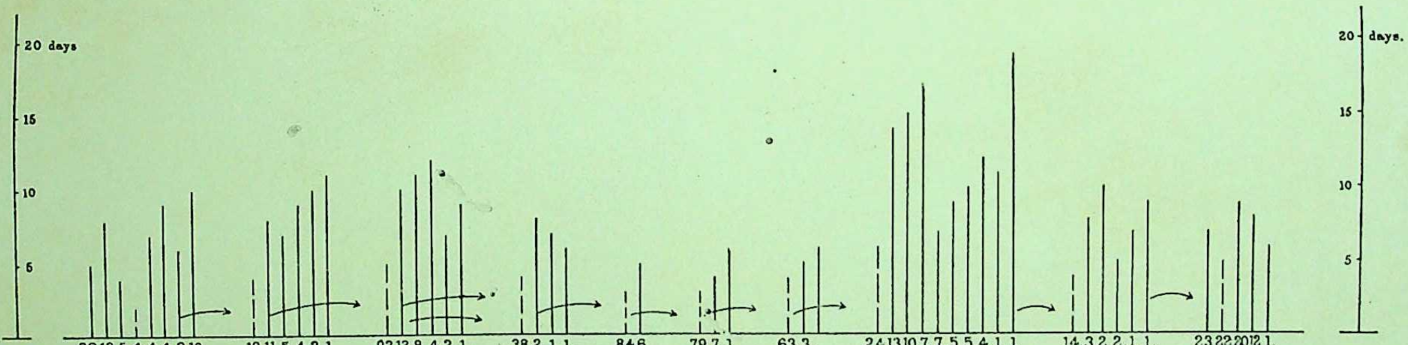
ERRATA.

On Plate II under Diagram III in the second group of figures representing numbers of individuals, *for* 21. 9. 4 *read* 21. 7 4.

On the same plate under Diagram IV in the same column, *for* 20. 7. 4 *read* 21. 7. 4

Plate III.

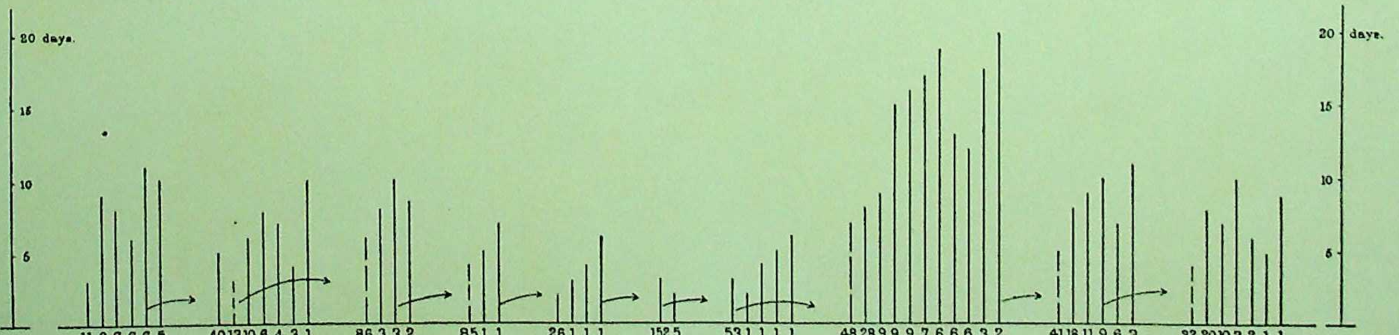
Diagram I.



Individuals	28.13.5.4.4.4.2.10.	19.11.5.4.2.1.	92.13.8.4.2.1.	38.2.1.1.	84.6.	79.7.1.	63.3.	24.1310.7.7.5.5.4.1.1.	14.3.2.2.1.1.	23.22.2012.1.
Generation	47 th	48 th	49 th.	50 th.	51 st.	52 nd.	53 rd.	54 th.	55 th.	56 th.
Date of Emergence	14 March 1917	25 April	2 June	10 July	12 Aug.	19 Sept.	25 Oct.	19 December	5 March. 1918	17 April 1918.
Duration of Larval and Pupal Stage	55 days	42 days	38 days	30 days	33 days	38 days	38 days	55 days	76 days	43 days.

Months	March 1917	April	May	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. 1918.	Feb.	Mar.	April
Mean Temperature	79·7	85·5	84·3	83·9	83·4	83·0	82·5	81·0	83·6	65·2	63·4	71·0	81·1	85·5
Maximum	100·0	103·1	98·1	96·6	92·1	91·7	91·7	90·0	86·6	80·1	77·8	92·0	98·8	103·1
Minimum	58·1	70·4	70·2	75·0	76·1	75·6	75·2	74·2	58·0	50·7	47·8	49·7	60·9	70·4
Average Rel. Humidity	80.	78.	79.	85.	88.	89.	87.	84.	82.	81.	85.	81.	80.	78.

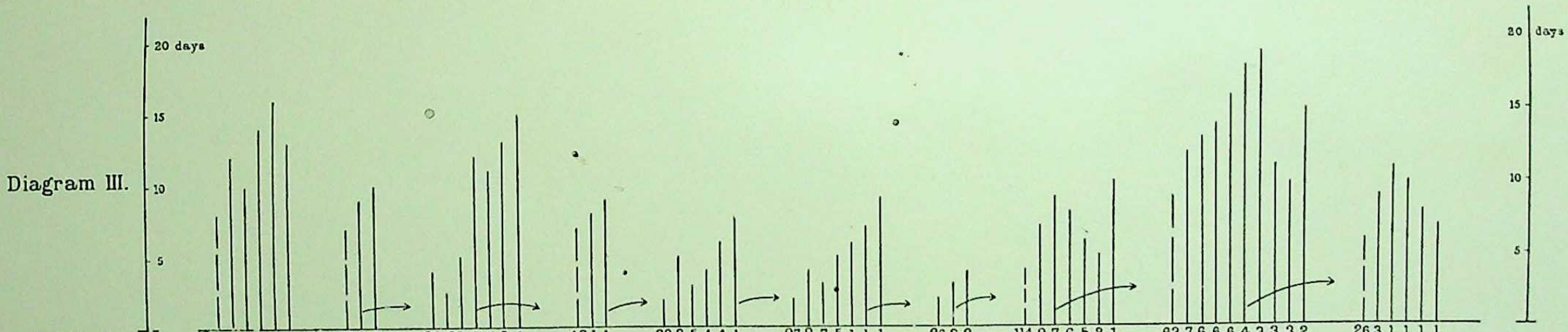
Diagram II.



Individuals	11.9.6.6.6.5.	40.1310.6.4.3.1.	86.3.3.2.	85.1.1.	26.1.1.1.	152.5.	53.1.1.1.1.	48.28.9.9.9.7.6.6.6.3.2.	41.18.11.9.6.3.	32.2010.3.2.1.1.
Generation	47 th.	48 th.	49 th.	50 th.	51 st.	52 nd.	53 rd.	54 th.	55 th.	56 th.
Date of Emergence	14 March 1917	23 April	31 May	9 July	10 Aug.	17 Sept.	24 Oct.	18 December.	5 March 1918.	6 April 1918.
Duration of Larval and Pupal Stage.	55 days	40 days	38 days	39 days	32 days	38 days	37 days	54 days	77 days	42 days.

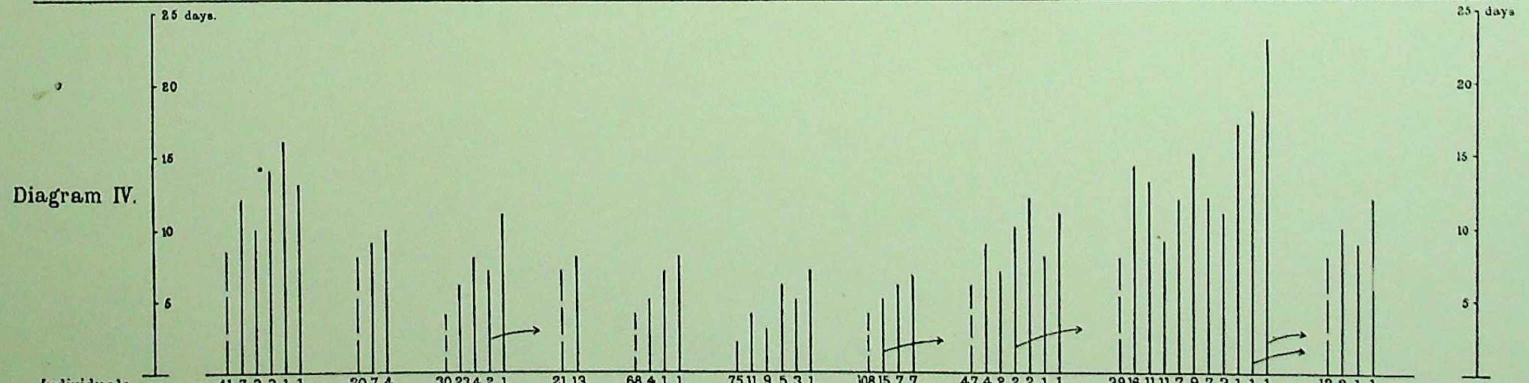
Diagrams I and II shewing the Vitality of Silkworm moths in Relation to the Seasons in Bengal.

The figures on the bare line shew the number of moths. The upright lines shew the number of days the moth have lived and must be referred to the column of figures on the left; the lengths of the uprights are proportional to the number of days shewn.



Individuals	41.7.3.3.1.1.	21 9.4	33 32. 7.5.2. 1	48 1.1.	38 8.5.4.4 1	97.8. 7 5 1. 1. 1.	26.2.2.	114.9.7.6.5.2.1.	63.7.6.6.6.4.3.3.3.2.	26.3.1.1.1 1.
Generation	46 th.	47 th.	48 th.	49 th.	50 th.	54 st.	52 nd.	53 rd.	54 th.	55 th.
Date of Emergence	28 Jan.1917	21 March	29 April	8 June	10 July	19 Aug.	24 Sept.	1 Nov.	1 Jan.1918.	15 March 1918.
Duration of Larval and Pupal Stage	76 days	52 days	39 days	40 days	37 days	35 days	36 days	38 days	61 days	73 days.

Months	Jan. 1917.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. 1918.	Feb.	March.
Mean Temperature	65·7	71·7	78·7	85·5	84·3	83·9·	83·4	83·0	82·5	81·0	73·6	65 2	63·4	71·0	81·1
Maximum	83·6	90·1	100·0	103·1	98·1	96·6	92·1	91·7	91·7	90·0	86·6	80·1	77·8	92·0	98·8
Minimum	47·3	53·6	58·1	70·4	70·2	75·0	76·1	75·6	75·2	74·2	58·0	50·7	47·8	49·7	60·9
Average Rel. Humidity			80.	78.	79.	85.	88.	89.	87.	84.	82.	81.	85.	81.	80.



Individuals	41.7.3.3.1.1.	20.7.4.	30.23.4.2.1.	21.13.	68.4.1.1.	75.11.9.5.3.1.	108.15.7.7.	47.4.2.2.2.1.1.	39.16.11.11.7.9.7.3.1.1.1.	12.2.1.1.
Generation	46 th.	47 th.	48 th.	49 th.	50 th.	51 st.	52 nd.	53 rd.	54 th.	55 th.
Date of Emergence	28 Jan.1917.	21 Mrch	1 May	8 June	15 July	22 Aug.	23 Sept.	1 Nov.	3 Jan.1918.	17 March 1918.
Duration of Larval and Pupal Stage.	76 days	52 days	41 days	38 days	37 days	38 days	32 days	38 days	63 days	73 days.

Diagrams III and IV shewing the Vitality of Silkworm moths in Relation to the Seasons in Bengal.

For Explanation see previous plate.

Proceedings of the Annual Meeting, 1919.

The Annual Meeting of the Asiatic Society of Bengal was held on Wednesday, the 5th February, 1919, at 9-15 P.M.

H. H. HAYDEN, Esq., C.S.I., C.I.E., D.Sc., B.A., B.A.I., F.R.S., F.G.S., F.A.S.B., President, in the chair.

The following members were present:—

Maulavi Abdul Wali, Dr. N. Annandale, Mr. J. J. Campos, Dr. H. G. Carter, Dr. W. A. K. Christie, Miss M. L. Cleghorn, Dr. L. L. Fermor, Rev. Father E. Francotte, S.J., Dr. F. H. Gravely, Mr. H. G. Graves, Mr. S. W. Kemp, Mr. D. McLean, Babu Ramesh Chandra Majumdar, Babu Panchanan Mukerjee, Dr. G. E. Pilgrim, Dr. Baini Prasad, Dr. Kiran Sankar Ray, Lt.-Col. Sir L. Rogers, Mahamahopadhyaya Haraprasad Shastri, C.I.E., Aga Muhammad Kazim Shirazi, Babu Ganapati Sircar, Lt.-Col. W. D. Sutherland, I.M.S., Mr. E. Vredenburg, Dr. Satis Chandra Vidyabhusana, Mr. H. Walker.

Visitors:—Mr. W. A. Burns, Mr. C. Cleghorn, Miss O. Cleghorn, Mr. B. M. Cooper, Mr. Y. Dewhurst, Mrs. Fermor, Babu Jyotish Chandra Gupta, Babu S. Mallik, Babu S. K. Mitter, Mr. G. Pilcher, Babu Manindra Mohan Ray, Babu Nritya Gopal Sarkar, Babu Sailendra Nath Sen, Miss M. Tannet, Mr. Joseph Taylor, Mr. S. K. Taylor, Mr. J. Thomas and others.

The President ordered the distribution of the voting papers for the election of Officers and Members of Council for 1919, and appointed Dr. Satis Chandra Vidyabhusana and Dr. L. L. Fermor to be scrutineers.

The President also ordered the distribution of the voting papers for the election of Fellows of the Society and appointed Dr. H. G. Carter and Babu Ramesh Chandra Majumdar to be scrutineers.

The President announced that the Trustees of the Elliott Prize for Scientific Research had awarded the prize for the year 1918 to Babu Bibhutibhushan Datta, M.Sc., for his two essays entitled " On the figures of equilibrium of a rotating mass of liquid for laws of attraction other than the law of inverse squares," and " On the motion of two spheroids in an infinite liquid along the common axis of revolution."

The President also announced that the Barclay Memorial Medal for the year 1919 had been awarded to Dr. N. Annandale, D.Sc., C.M.Z.S., F.L.S., F.A.S.B.

The Annual Report was then presented.

ANNUAL REPORT FOR 1918.

The Council of the Asiatic Society has the honour to submit the following report on the state of Society's affairs during the year ending 31st December, 1918.

Member List.

The number of Ordinary Members at the close of 1918 was 382. The number of Ordinary Members elected during 1918 was 36. Out of these eight have not yet paid their entrance fees, one has died and another has asked that his election be cancelled. The number of Ordinary Members added, therefore, is 26. Two members elected in 1917 have paid their entrance fees during the year, making a total of 28 Ordinary Members added to the last list. On the other hand, 12 have withdrawn, 3 died, 5 were struck off under Rule 38, and 4 were struck off under Rule 40.

The number of Ordinary Members in the past six years is as follows :—

YEAR.	PAYING.				NON-PAYING.			GRAND TOTAL.
	Resident.	Non-Resident.	Foreign.	Total.	Life.	Absent.	Total.	
1913	200	211	19	430	23	46	69	499
1914	191	187	19	397	26	50	76	473
1915	171	188	21	380	25	40	65	445
1916	145	159	18	322	25	60	85	407
1917	150	144	15	309	24	45	69	378
1918	153	145	17	315	24	43	67	382

The following members died during the course of this year :—Syed Abdulla-ul-Musawy, B.A., Maharaja Ranjit Singha, and Dr. Arthur Venis, C.I.E.

No members compounded for their subscriptions during this year.

The numbers of Special Honorary Centenary Members and Honorary Fellows remain unchanged at 2 and 22 respectively.

Among the Associate Members the names of Dr. Ekendra Nath Ghosh and Bada Kaji Maricheman Singha have been removed at their own request, they having been elected Ordinary Members of the Society. The number is now 10.

Fellows of the Society.

At the Annual Meeting held on the 6th February, 1918, Colonel Sir Sidney S. Burrard, K.C.S.I., F.R.S., J. L. Simonsen, Esq., Ph.D., Lieut.-Colonel J. Stephenson, D.Sc., I.M.S., Major D. McCay, M.D., I.M.S., and the Hon. Mr. Abdullah Al-ma'mun Suhrawardy, M.A., Ph.D., were elected Fellows of the Society.

There was one death among the Fellows, viz. Dr. A. Venis.

There were 39 Fellows on the list at the end of 1918.

Office-bearers.

On the death of Dr. W. C. Hossack in the beginning of the year, Major D. McCay was appointed Medical Secretary. Dr. F. H. Gravely resigned the office of General Secretary at the end of February and Dr. W. A. K. Christie was appointed in his place. Dr. (now Sir) P. C. Ray succeeded Dr. Christie as Physical Science Secretary. Dr. N. Annandale resigned the Anthropological Secretaryship owing to his absence from Calcutta and Dr. Gravely was appointed in his place. Dr. Gravely was also appointed to act as Biological Secretary during the absence of Mr. S. W. Kemp. At the request of Mr. C. J. Brown, Lieut.-Col. H. Nevill undertook to report on treasure trove coins from the Central Provinces in addition to his own duties as Honorary Numismatist to the Society.

There have been no other changes among the Officers of the Society since the last annual election.

Office.

On the recommendation of Major D. McCay, I.M.S., Mr. J. H. Elliott, the Assistant Secretary, was granted leave from 19th July to 1st August, 1918, owing to ill-health.

Shaikh Abu Nasr Gilani, the Additional Travelling Maulavi attached to the Arabic and Persian Search Department, worked until the 28th February, 1918, when he resigned, and Maulavi Haji Moinuddin was appointed from the 24th May, 1918.

There have been no other changes in the establishment.

Society's Premises and Property.

On account of war conditions the building of new premises for the Society has not yet been taken in hand.

The Society's servants' quarters have been repaired at a cost of Rs. 338.

Indian Museum.

No presentations were made to the Indian Museum.

The Hon. Justice Sir Asutosh Mukhopadhyaya, Kt., C.S.I., D.Sc., F.R.A.S., F.R.S.E., still continued to be a member of the Board of Trustees on behalf of the Society under the Indian Museum Act X of 1910.

Indian Science Congress.

The Fifth Indian Science Congress was held in Lahore on January 9th, 10th, 11th and 12th, 1918, under the presidency of Dr. Gilbert T. Walker, C.S.I., M.A., Sc.D., F.R.S. The meetings were attended by about 300 members and over 70 papers were communicated. Abstracts of these have been published in our Proceedings, Vol. XIV, 1918, pages lxxv-clxxxvii.

It was arranged that the Sixth Indian Science Congress should be held at Bombay on January 13th, 14th, 15th, 16th, 17th and 18th, 1919. His Excellency the Governor of Bombay, Sir George Lloyd, G.C.I.E., D.S.O., consented to be Patron and Lieut.-Col. Sir Leonard Rogers, Kt., C.I.E., M.D., B.S., F.R.C.P., F.R.C.S., F.R.S., F.A.S.B., I.M.S., was appointed President, with Dr. J. L. Simonsen as Honorary-Secretary and Mr. A. Normand of the Wilson College, Bombay, and Mr. D. D. Kanga of the Elphinstone College, Bombay, as Local Secretaries.

Meetings.

There were no General Meetings of the Society during the months of January and March, 1918, owing to a quorum not being present. There were also no meetings in the recess months of September and October, 1918.

On the recommendation of the Publication Committee the Council decided for the present to discontinue the system of having alternate Scientific and Philological Meetings and ordered that all papers passed for reading should be read as submitted.

In connection with the reading of papers at the General Meetings, it was resolved that the author of a paper or his deputy must be present to read it, if it should not be so technical as to necessitate its being taken as read.

London Agency.

Mr. Bernard Quaritch has continued as the Society's Agent in Europe.

No copies of the *Journal and Proceedings*, *Memoirs* or *Bibliotheca Indica* were sent to Mr. Quaritch for sale, owing to orders prohibiting the transmission of books for sale to Europe, but it is intended that all the numbers issued since the commencement of the war should be sent in 1919.

Barclay Memorial Medal.

In terms of the rules for the award of the Barclay Memorial Medal, there was no award during the year.

In connection with the award for 1919, the following members were appointed to form a Special Committee to make recommendations to the Council :—F. H. Gravely, Esq., D.Sc., F.A.S.B., Lieut.-Colonel W. D. Sutherland, M.D., F.A.S.B., I.M.S., Major D. McCay, M.D., F.A.S.B., I.M.S., B. L. Chaudhuri, Esq., B.A., D.Sc., F.R.S.E., F.L.S., and H. G. Carter, Esq., M.B., Ch.B.

Elliott Prize for Scientific Research.

The subject selected for the Elliott Prize for Scientific Research for the year 1918 was Mathematics, and the notification appeared in the *Calcutta Gazette*, dated 4th July, 1917 and 13th February, 1918. Two essays by Babu Bibhutibhushan Datta, M.Sc., were received in competition, viz. (1) On the figures of equilibrium of a rotating mass of liquid for laws of attraction other than the law of inverse squares, Part I, (2) On the motion of two spheroids in an infinite liquid along the common axis of revolution. The Trustees decided to award to him the Elliott Prize for 1918. In terms of the notification, the award of Rs. 210 will be made to him at the Annual Meeting of the Society on Wednesday, the 5th February, 1919.

Finance.

The accounts of the Society for the year ending 31st December, 1918, are shown in the Appendix under the usual heads, with two additional statements, viz. :—"International Catalogue of Scientific Literature" and "War Bond." Statement No. 21 shows the Balance Sheet of the Society and of the different funds administered through it.

The credit balance at the close of the year is Rs. 1,96,833-3-3, against Rs. 1,88,429-10-6 at 31st December, 1917. Of this amount Rs. 1,68,500 belongs to the Permanent Reserve, the working balance—exclusive of funds administered for Government—being Rs. 28,333 as against Rs. 20,650 at the end of 1917. This increase is chiefly due to the transfer of Rs. 5,000 from the Anthropological Fund to the Society's Fund. The Anthropological grant of Rs 2,000 has now been made available by the Government of Bengal for the publication in the *Journal* of papers not necessarily relating to anthropology.

The Society has received the usual grants from the Governments of Bengal and India, including the Oriental Publication Fund No. 2, which has been received for a further period of 5 years from April, 1917. The amounts received were as follows :—

From the Government of Bengal—	Rs.	*Vide* Statement
International Catalogue of Scientific Literature	1,000	No. 7
Oriental Publication Fund, No. 1	9,000	,, 8
Do. No. 2	5,000	,, 9
Bureau of Information ..	1,200	,, 11
Anthropological Fund ..	2,000	,, 12
Sanskrit MSS. Fund	5,600	,, 13
TOTAL ..	23,800	

From the Government of India—	Rs.	*Vide* Statement
Arabic and Persian MSS. Fund ..	5,000	No. 14

Statement No. 15 shows the sums invested in Government securities, held in deposit by the Bank of Bengal, of the face value Rs. 2,84,300. These comprise Rs. 2,74,200, 3½ % and Rs. 10,100, 4 % G.P. Notes. They cost Rs. 2,73,206-3-10, the average purchase price being Rs. 96-1-6. The market price at the time of writing this report is nominally Rs. 74. We have also in the custody of the Alliance Bank of Simla Ltd., 3½ % G.P. Notes of the face value of Rs. 500 belonging to the Barclay Memorial Fund.

The Budget estimates for the year 1918 were :—Receipts Rs. 21,300, Expenditure Rs. 21,734. The actual result is Receipts Rs. 26,053, Expenditure Rs. 19,538. This shows an apparent excess of income over expenditure amounting to Rs. 6,516 : of this, however, a sum of Rs. 5,082 is required to meet expenditure incurred on account of publications issued during the year. Other papers accepted in 1918 for future publication will involve a further sum of Rs. 4,323, but this will not become payable till 1919.

The Budget Estimate of Receipts and Expenditure for the year 1919 is as follows :—

	Rs.
Receipts	23,953
Expenditure	19,762

The Permanent Reserve Fund has been increased by adding Admission fees of Rs. 900 and now stands at Rs. 1,68,500.

Outstandings from last year still due to the Society, chiefly on account of subscriptions and publications, amount to Rs. 1,888. This sum, if added to Rs. 6,515, the difference between the actual receipts and the expenditure for the year 1918 brings the apparent surplus from the year up to Rs. 8,403, which is the difference between the respective balances for the years 1917 and 1918, as shown in statement No. 1 of the Abstract.

BUDGET ESTIMATE FOR 1919.

Receipts.

	1918. Estimate.	1918. Actuals.	1919. Estimate.
	Rs.	Rs.	Rs.
Members' Subscriptions ..	9,000	8,445	9,000
Subscriptions for the Society's *Journal and Proceedings* and *Memoirs* ..	1,700	1,920	1,920
Sale of Publications ..	1,300	1,053	1,100
Interest on Investments ..	8,500	8.913	9,233
Rent of Room.. ..	600	600	600
Miscellaneous	200	122	100
Government allowance—formerly included in the Anthropological Fund Account—for publication of papers in the *Journal* ..	..	5,000	2,000
TOTAL ..	21,300	26,053	23,953

Expenditure.

	1918. Estimate.	1918. Actuals.	1919. Estimate.
Salaries	7,120	6,746	5,955
Commission	950	799	600
Stationery	150	103	100
Pension	180	197	228
Light and Fans ..	280	96	200
Taxes	1,500	1,495	1,500
Postage	430	532	500
Freight	20	..	500
Contingencies	500	373	500
Books	500	584	500
Binding	700	192	500
Journal and Proceedings and *Memoirs*	6,640	6,211	6,650
Indexes	800	..	400
Printing (Circulars, etc.) ..	360	263	300
Auditor's fee	150	150	150
Petty Repairs	10	74	200
Insurance	344	344	344
Grain Allowance ..	100	28	..
Repairs	500	338	..
Carried over ..	21,234	18,525	19,127

	1918. Estimate.	1918. Actuals.	1919. Estimate.
	Rs.	Rs.	Rs.
Brought forward ..	21,234	18,525	19,127
To Personal Account (Written-off and Miscellaneous)	500	749	500
Interest on G.P. Notes purchased	..	57	..
War Bonus	..	207	135
TOTAL ..	21,734	19,538	19,762

Library.

The total number of volumes and parts of magazines added to the Library during the year was 1,889, of which 271 were purchased and 1,618 were either presented or received in exchange.

A complete set of the "Ohio Naturalist," Vols. I-XV, 1900–1915, has been presented to the Society by the Ohio State University, Columbus.

The work of copying the missing pages of the Society's Kangyur and Tangyur from the Tibetan set of the Calcutta University was completed.

At the suggestion of the Librarian, Imperial Library, the Council agreed to the compilation of a subject-analysis of the books lent out to members of the Society and ordered that the lists should be circulated quarterly to the Library Committee.

The Council ordered that the books bound and others ready for binding should be placed on the table at each of the meetings of the Library Committee.

It was ordered that the Library Committee should meet on the last Wednesday of the first month of each quarter.

Publications.

Seven numbers of the *Journal and Proceedings* (Vol. XIV, Nos. 1–7) were published during the year containing 630 pages and 11 plates.

Three numbers of the *Memoirs* were published, Vol. VI, Parts 4 and 5, and Vol. VII, No. 1, containing a total of 240 pages and 3 plates.

The Numismatic Supplement Nos. XXX & XXXI have been published in the Society's *Journal and Proceedings*, Vol. XIV, 1918, Nos. 3 and 5, under the editorship of Lt.-Col. H. Nevill.

The Indexes to the *Journal and Proceedings*, Vol. IX, 1913 and Vol. X, 1914, were published. Arrangements have been made for the preparation of the Indexes for Vols. XI–XIII, 1915–1917 but no manuscript has yet been received. It was resolved that the indexes to the papers to the subsequent volumes should be prepared by the authors themselves and all authors are now asked to index their own papers.

It was also resolved to index the *Memoirs* individually and the Indexes to Vol. III, Nos. 6 and 7 and Vol. V, Nos. 3 and 4, were published.

There was also published a "Catalogue of the Scientific Serial Publications in the Principal Libraries of Calcutta," compiled by Mr. S. W. Kemp, and on sale at Rs. 5.

Exchange of Publications.

During the year the Council accepted two applications for exchange of publications, viz. :—(1) from La Société d'Etudes Océaniennes, Papeete (Tahiti)—the Society's *Journal and Proceedings* and *Memoirs* for their *Bulletin*, (2) from Tohoku Imperial University—the Society's *Journal and Proceedings* for their *Arbeiten*.

On an application from the Secretary of the Navadwipa Edward VII Anglo-Sanskrit Library, one copy of each complete volume available of the Sanskrit series of the *Bibliotheca Indica* was presented to the library.

Philology, etc.

An account of an Iranian dialect known as Ormurī or Bargista by Sir George Grierson has been published in the *Memoirs* of the Society, Vol. VII, No. 1, 1918. This dialect is spoken by a tribe which calls itself Baraki, and is settled in the country of the Waziris in Afghānistan. The Barakis were originally inhabitants of Yemen in Arabia, and were brought by Sultan Maḥmud of Ghaznī to accompany him in his invasion of India. The account of the dialect is principally based on a work entitled *Qawāid-i-Bargista*, partly in Urdū and partly in Pushto. A careful examination of the dialect has proved it to be of Iranian origin. In the appropriate volume of the Linguistic Survey, a full grammar and vocabulary of it will appear. It has been treated in the present work from the point of view of comparative philology

The Rev. W. K. Firminger has edited the Malda Diary and Consultation Book, 1680–1682, in which several important events are recorded. The English carried on business first in a hired house at Malda, subsequently they purchased a piece of land about two miles distant from their factory, now the civil station of Malda, and ever since known as the "English Bazar." The third part of the Diary chronicles events during and subsequent to the completion of the factory at "English Bazar."

Mr. H. Beveridge has contributed a paper on the *Rawzat-ut-Tāhirīn,* which is a general history. It begins from the earliest times, and is carried down to the beginning of the 17th century, and contains five divisions, subdivided into chapters and sections. Notices of the work are found in Elliot's History of India, the British Museum Catalogue of Persian MSS., and the Bodleian Library Catalogue, The contents of the work, and the discrepancies in the copies noticed in the catalogues, are fully set forth in the paper.

Maulavī Ḥāfiz Nazīr Aḥmad, the Society's First Travelling Maulavī, has contributed the second instalment of notes on important Arabic and Persian MSS. with an introduction by the Hon. Dr. A. Suhrawardy, Officer-in-charge of the Search for Arabic and Persian MSS. There are notes on 4 Arabic and 315 Persian MSS., and descriptive notes on 5 libraries visited by the Maulavi.

During the year under review Mahāmahopādhyāya Dr. Satis Chandra Vidyābhusana contributed to our *Journal* a paper on the "Tattva-Cintamoni," a most advanced Sanskrit work on the modern school of Hindu Logic, compiled in the 14th century A.D. by a Maithil Brahmin named Gangeśa Upādhyāya. The paper, while dealing with the abstruse topics of inductive and deductive reasoning, discusses at length the sources of true knowledge as derived through perception, inference, comparison and verbal testimony.

"Bhavabhuti as a Mīmānsaka" is the title of a paper in which Babu Dinesh Chandra Bhattacharyya identifies Bhavabhuti, the great Sanskrit dramatist of the 8th century A.D. with Umbekā Chāryya, a philosopher of the Mīmānsa School, on the authority of certain observations contained in a manuscript of the Mālatīmādhava and in a commentary on the Citsukhī.

"A short account of the wandering teachers at the time of the Buddha" is the title of a contribution in which Babu Bimala Charan Law mentions certain Paribbājakas or wandering ascetics who dicussed various current topics and are supposed to have paved the way for a science of polity at the time of Cānakya.

Anthropology.

Dr. Annandale's note in the *Journal* on a Bismer Weighing Beam from the Darjeeling District is the only paper relating to anthropology that has been published this year.

Biology.

ZOOLOGY.

The fourth and fifth parts of Dr. Annandale's "Zoological Results of a Tour in the Far East" have appeared in the *Memoirs.* They deal with Brackish-water Polyclads (T. Kabu-

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raki), Sponges (N. Annandale), Crustácea Decapoda and Stomatopoda (S. W. Kemp) and the Mollusca of the Tai-Hu (N. Annandale). D. R. Bhattacharya has published in the *Journal* Notes on the Anatomy of a Double Monstrosity in the Chick.

BOTANY.

Three botanical papers have been published in the *Journal*: Some observations on the rust on *Saunea asplenipolia* by K. C. Mehta; A Preliminary Note on the Flora of the Anaimalais by C. Fischer; and The Burmese Sesamum Varieties by A. McKerral.

Physical Science.

Two papers on physics were published during the year—On a new Theorem in Elasticity, by M. N. Saha, and On the Pressure of Light by M. N. Saha and S. Chakravarti. From the equations of motion of an elastic system, a new equation is obtained in the first paper analogous to Clausius's viral theorem. This theorem expresses the differences between the mean kinetic, and mean potential energies of an elastic system in terms of surface tractions, and surface displacements. In the second paper, Messrs. Saha and Chakravarti describe a very simple apparatus with the aid of which they were able to measure the pressure of light from a tungsten lamp of 3,000 C.P. The apparatus can be easily constructed and is entirely free from any disturbing actions.

One chemical paper was published, On Porphyroxine, a new alkaloid in opium, isolated by the author, Mr. J. N. Rakshit.

Medical Section.

Owing to the continued absence at the war of a large number of the medical members there was no meeting during the year 1918.

It is gratifying to learn that the Indian Science Congress has included medical science within its scope.

It is hoped that during 1919 many papers will be contributed to the medical section of the Society.

International Catalogue of Scientific Literature.

The Secretary of the Regional Bureau for India and Ceylon (Sir P. C. Ray) reports that during the year no volumes of the Catalogue were received from the Central Bureau, but it is expected that with the abatement of war risks parcels are probably now on the way.

The indexing of the literature for the year has been resumed and a few hundred slips will be ready for despatch to the Central Bureau during March and April, 1919.

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The work of the Bureau has necessarily been much less than in previous years as the distribution of the Catalogue to subscribers and the collection of subscriptions have been suspended, but it is hoped that next year's report will be equal to the standard of pre-war years.

Bureau of Information.

A few questions were answered and an opinion was given on the Intercaste Marriage Bill.

Sanskrit Manuscript Search and Catalogue.

All search work was stopped under orders of the Council.

Out of 11,164 MSS. 10,600 have been described. Sixteen hundred of these giving descriptions of the Vedic Section of the collection are ready for the Press after classification and revision.

Arabic and Persian Manuscript Search and Catalogue.

During the year ten Arabic and Persian MSS., and one Persian book, containing biographies of poets, were purchased on behalf of Government. The following four Arabic MSS. are worthy of notice :—(1) *Al-Qabs-ul-Hāvī*, a rare biographical work. It contains lives of eminent persons, who flourished from the 8th to the 10th century of the Hijra, by Abd-us-Salām, died 931 A.H. = 1525 A.D. (2) *Musnad-i-'Umar bin 'Abd-ul-'Azīz*, the 8th Caliph of the House of Umayya, died 101 A.H. = 720 A.D. This work, which is very rare, contains traditions collected by Abū Bakr Muḥammad bin Muḥammad. (3) *Sunan-i-Imām Shāfi'ī*. This work is also rare, and contains traditions collected by Aḥmad bin Muḥammad bin Salāma, died 321 A.H. = 933 A.D. (4) *Fatāwā-i-Qāsim bin Quṭlūbghā*, died 879 A.H. = 1474 A.D., a collection of legal opinions according to the Hanafī school.

The second instalment of the notices on important Arabic and Persian MSS., found in various libraries in India, prepared by the First Travelling Maulavī under the supervision of the Hon. Dr. A. Suhrawardy, Officer-in-charge of the Search for Arabic and Persian MSS., has been published in the *Journal*, Vol. XIV, 1918, No. 8. The Maulavī is now making an inspection of the private libraries in Calcutta, with a view to taking notes of rare and interesting Arabic and Persian MSS. Maulavī Ḥājī Mu'in-ud-Dīn Nadvī was appointed an Additional Travelling Maulavī in May last, in the place of Shaikh Abū Nasr Gīlānī, to continue the preparation of the hand-list of the Government MSS. Under the instructions of the Officer-in-charge of the Search, he was deputed to the Oriental Public Library, Bankipur, to inspect some MSS. there and compare certain MSS. of the Government collection with those of the Oriental Public Library. He has submitted a very interesting report of his work. The amplification of the Society's *Catalogue of Persian MSS.* by Maulavī Asad-uz-Zamān Khān is in progress. The Second Travelling Maulavī is preparing notices of important Persian MSS. of the Government collection.

Bibliotheca Indica Series.

Of the eleven fasciculi of texts published in the *Bibliotheca Indica* series during the year under review, four belong to the Brahmanic Sanskrit, one belongs to the Jaina Sanskrit, one to the Buddhist Sanskrit, two to the bardic dialect of Rajputanā, and three to the Arabic and Persian languages. These include the Tibetan and Sanskrit version of the last fasciculus of Avadāna Kalpalatā, an English rendering of a fasciculus of Akbarnamā and the English translation of a fasciculus of Tantra Vārthika. The eleven fasciculi that have been published are mentioned below:—

(1) Baudhāyana Srauta-Sūtram—a Sanskrit work on the Vedic literature, edited by Dr. W. Caland. Fasciculus II.

(2) Nyāyā-Vārthika-Tātparya-Pariśuddhi of Udayanācārya, edited by Mahāmohopādhyāya Pandit Vindhyeswari Prasad Dirvedi. Fasciculus V.

(3) The Tantra-Vārthika of Kumārila Bhaṭṭa—a Commentary on Śabara's Bhāsya on the Pūrva Mīmānsā Sūtra's of Jaimini, translated into English by Mahāmohopādhyāya Gaṅgānāth Jha, M.A., D. Litt. Fasciculus XV.

(4) Pṛthvīrāja Vijaya—a Sanskrit epic with the commentary of Jonarāja. By S. A. Belvarkar, M.A., Ph.D. Fasciculus II.

(5) Yoga-Śāstra with the commentary of Srī Hem Chandrāchārya, edited by Cri Vijaya Dharma Sivū. Fasciculus V.

(6) Avadāna Kalpalatā—a Sanskrit work on the Miracles of Buddha with its Tibetan version, edited by Mahāmohopādhyāya Satis Chandra Vidyābhusana, M.A., Ph D., and the late Rai Sarat Chandra Das Bahadur, C.I E. Fasciculus XIV.

(7–8) A Descriptive Catalogue of Bardic and Historical Manuscripts, Sections I and II, edited by Dr. L. P. Tessitori.

(9) Haft-Iqlim—the Geographical and Biographical Encyclopaedia of Amin Ahmad Rāzi, edited by Dr. E. Denison Ross, Ph.D., C.I.E., and Khān Sāhib Maulvī Abdul Muqtadir. Fasciculus I.

(10) Amal-i-Sālhi or Shāh Jahān Nāmāh of Muhammad

Sālih Kambo, edited by G. Yazdani M.A., M.R.A.S. Fasciculus III.

(11) The Akbar-Nāma of Abul-Fazl—a history of the reign of Akbar including an account of his predecessors, translated from the Persian by Mr. H. Beveridge, I.C.S. Fasciculus X.

Coins.

The thanks of the Society are due to the Government of Madras for the gift of 14 gold coins, all save one of these being specimens of the various types comprising the large find at Kodur, District Nellore, in 1913. Among other small additions to the cabinet, mention should be made of the Surī coins received from the Government of Bihar and Orissa.

In the two Numismatic Supplements published during the year the principal contributors were Mr. S. H. Hodivala, who has added to his valuable papers on Mughal mints, and Mr. Furdoonji D. J. Paruck, who has continued with success his researches in the field of Sāsānian and Parthian numismatics. A considerable amount of material awaits publication, the delay being due to financial considerations alone.

During the year 1918 ten finds of coins, comprising 9 of gold, 180 of silver and 598 of billon and copper from the Central Provinces were examined. In addition to this a large trouvaille of some 1,200 Bahmani coins awaits examination. While the cabinet of the Nagpur Museum has been improved by the acquisition of treasure trove coins to a considerable extent, very few specimens of rare types have been discovered, and the only new variety brought to light is a copper coin of Akbar struck at Dāru-l-Khilāfat Akbarpūr in 982 H.

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Dr. H. H Hayden, F.R.S., President, delivered an Address to the Society.

Annual Address, 1919.

The Annual Report, which is in your hands, speaks for itself and requires no comment from me. The work done during the past year has been on the whole satisfactory. It was found necessary to curtail the Society's activities in certain respects, but now that the war is virtually over, it is to be hoped that this will no longer be necessary.

For my address to you last year I selected a subject that I hoped would be of interest not merely to the geological section of our members, but to the Society as a whole. I propose to follow the same course again this year and to put before you briefly to-night the results of recent research on the subject of geological Time, especially in its bearing on the question of the antiquity of the human race.

When geological observation first came to be systematized, it was found that the sedimentary rocks of Europe fell naturally into a number of broad divisions, each distinguished from the other by the fossils that it contained and each having a definite and constant position in time and sequence. In a normal group of such sedimentary rocks, the oldest, being the first to be deposited, would naturally be found below and the youngest above; and although subsequent movements of the earth's crust have often disguised the true sequence, the presence of fossils has served as an unerring guide in the unravelling of what has sometimes appeared to be the most hopeless confusion. The broad divisions into which the fossiliferous rocks have been found to fall naturally are known as the Palæozoic, Mesozoic and Kainozoic groups. Each of these groups has again been sub-divided into smaller units, known as systems. Most countries have adopted nomenclatures of their own but, in every country, whether it be America, Africa, Australia or India, the equivalents of the European systems have been recognised, and the general aspect and sequence of their fossil contents is the same. It has thus been possible to trace the development of the animal kingdom, though not from its beginning, at least from an early stage in its history. In the Cambrian rocks we find only the remains of invertebrates; in the next system we find fishes, in subsequent systems reptiles, and later still birds; in the Tertiary rocks we find the remains of mammals, and lastly in the Pleistocene and Recent (Quarternary) the remains of man. The lowest forms of life have no hard parts, and, when buried amongst accumulating sediments, merely decompose, leaving no remains by which they may ultimately be recognised; the fossil record, therefore, begins only with animals or plants which have hard parts and which clearly represent a stage of evolution far removed from that of the primitive protozoa. Even before the Cambrian period, there must have been an enormous lapse of time during which geological processes were in operation, a period, in fact, probably greater than that which has elapsed since the beginning of the Cambrian epoch down to the present day. That earlier period is also repesented by a vast sequence of rocks, amongst the youngest of which some traces of fossils have been recently recognised, but most of which are either the products of crystallization from molten magmas or of alteration by heat and pressure—and consequent re-crystallization—of pre-existing rocks Like the fossiliferous rocks, the pre-Cambrian have also been sub-divided into numerous groups, but to-night we are concerned only with their broader divisions, the oldest of which is known as the Archaean.

Expressed in the above terms, the geological time-scale is essentially a relative one, and gives no indication of absolute duration in years. Since the middle of the nineteenth century, many attempts have been made, with widely differing results, to translate that scale into years. More than fifty years ago, Lyell suggested 250,000,000 years as the age of the earth. Other estimates were as low as 10 or 12 million, the latter based chiefly on physical arguments bearing on the age of the sun as deduced from its present temperature ; and towards the close of the nineteenth century, Lord Kelvin's figure of 40 million years was widely accepted as the maximum possible. Other estimates were based on the rate of denudation and deposition of sediment, as measured by the amount of material carried in suspension by the great rivers of the present day, and on this basis Prof. Sollas arrived at a period of 80 million years, the time required for the deposition of the sedimentary rocks, the thickness of which he estimated to be nearly 336,000 feet. Prof. Joly attacked the problem along another line, and, by computing the amount of sodium contributed annually to the sea in consequence of the denudation of the igneous rocks, estimated the time that would be required for the accumulation of the total salt now in the sea. He arrived at an age of 96 million years. These and other estimates were much above the maximum that most physicists regarded as possible, and it became clear that either the deductions based on geological processes were erroneous or that the physical calculations of the age of the earth, based on the rate of loss of heat by the earth and the sun, involved some fallacious assumption. The latter proved to be the case, for the fundamental assumptions on which the physical calculations rested were vitiated by the discovery of the phenomena of radio-activity, which provided a hitherto unsuspected source of heat, and an age for the earth of between one and two thousand million years was no longer considered improbable on physical grounds. At the same time, further investigations of radio-activity led to an entirely new method of attacking the problem of the age of the rocks of the earth's crust and one which promises to yield results of the greatest importance and of remarkable accuracy. This method is based on the discovery that the element uranium gradually breaks up into other elements such as helium and radium, the last in the series of derivatives being apparently lead. It is further possible to ascertain the amounts of these derivatives, such as helium, radium and lead, occurring in any uranium-bearing mineral and also to determine the rate at which their decay, as well as that of the parent element, takes place ; from these data the period during which decay has been taking place, that is to say, the time which has elapsed since the uranium-bearing mineral was formed, can be calculated. In this way, minimum ages have been determined for radio-active minerals occurring in a number of different geological systems and have given results ranging from 100,000 years in the case of minerals in the Recent lavas of Vesuvius to 1,400 million years for others in the Archaean rocks of Canada, which are among the oldest rocks of the earth's crust. The results thus given by radio-active minerals have recently been compared and combined by J. Barrell with those obtained from other geological methods of determining the age of the fossiliferous rocks, and the results are shown in the annexed table.

	MILLIONS OF YEARS.			
	Minimum.		Maximum.	
Recent Pleistocene	1		1½	
Pliocene	6		7½	
Miocene	12		14	
Oligocene	16		16	
Eocene	20		26	
		55		65
KAINOZOIC.				
Cretaceous	65		85	
Jurassic	35		45	
Triassic	35		45	
		135		175
MESOZOIC.				
Permian Carboniferous	110		130	
Devonian	50		50	
Silurian	40		40	
Ordovician	90		130	
Cambrian	70		110	
		360		460
PALÆOZOIC.				
TOTAL ..		550		790

From this we may deduce that the trilobites appeared first between 550 and 700 million years ago, the first fish between 350 and 400 million years ago, and the birds about 150 million years ago. The first unmistakable mammals appeared at about the same time as the birds, or possibly earlier, but the *Mammalia* as a class reached their maximum development in the Tertiary epoch and especially in the Miocene and Pliocene periods, say, between five and ten million years ago. The remains of large mammals are extremely abundant in the Siwalik rocks of the Himalaya and the Punjab.

The last stage, so far achieved in the history of mammalian development was ushered in by the appearance of man, and it will be interesting to enquire what length of time has elapsed since that occurred.

In his relation to the geological record man differs from all other animals, for whereas the existence of the latter at any particular epoch can be inferred only from their actual bodily remains—or in a few cases from their footprints—man has left behind him the results of his handiwork, and it is by these more often than by his bones that his former presence has been detected. The commonest of his productions are implements of various kinds; in the earliest days they were made of stone, subsequently also of bone, and finally of bronze and iron. Thus, in the history of human implements or *artifacts*, as they are technically called, three principal periods are recognised: the Stone Age, the Bronze Age, and the Iron Age; it is the earliest or Stone Age that marks the first appearance of man, and that is the age with which we are now concerned. All over the world stone implements are found which are clearly man's handiwork and are often associated with the remains of extinct animals and of man himself. The implements are usually divided roughly into two classes—one characteristic of an older and rougher culture and the other showing evidence of more elaborate and more artistic workmanship and design; these implements are known as palæoliths and neoliths respectively; the former are found in great numbers in Pleistocene deposits in association with the remains of extinct types of elephant, rhinoceros, bear, hyæna and many other animals that have long disappeared from Europe. The earliest of these palæoliths is what is known as the *coup de poing*, a large pointed implement supposed to have been held in the hand. In Europe most of the early implements were made of flint, though other hard rocks were also used to some extent; in India, on the other hand, most of the known palæoliths are of quartzite, flint being much more characteristic of the succeeding neolithic culture.

In addition to palæoliths and neoliths, there is a third class, known as eoliths. They are a more recent discovery, and there has been much controversy as to whether they are really the products of human agency or merely the results of natural fracture. Eoliths are found in the upper division of the Tertiary system, but it is in the deposits of the Pleistocene or Glacial epoch that the first unequivocal and undisputed relics of man occur. The Glacial epoch was characterised by a great fall of temperature all over the northern hemisphere and the extension of snow and ice far to the south of their present limits, the climate of Britain and much of Europe becoming arctic; such conditions, however, did not persist throughout the whole Glacial epoch, but there were intervals, known as Interglacial, during which the climate became warm, and temperate conditions again prevailed, while the glaciers retreated to the north. The most characteristic deposit of the Glacial epoch is the boulder-clay, which is a clay through which large numbers of pebbles and boulders of all sizes are irregularly distributed; it is the direct product of glacial action, and its occurrence at any particular spot bears witness to the former presence of glaciers there. While the boulder-clay is characteristic of glaciation, the presence of fluviatile and lacustrine deposits associated with the remains of mammals of a type living in warm climates is equally characteristic of the interglacial intervals. Deposits of both kinds are common throughout the British Isles and are found to alternate with one another, thus indicating fluctuations of climate: in this way, the occurrence of as many as six Glacial and five Interglacial epochs has been established in Europe. It is in the river deposits of the Interglacial epochs that the oldest relics of Pleistocene man have been discovered. Later on man became a cave-dweller, and records of successive stages in the history of his development have been left by him, in the form of remains either of himself or of his handiwork, in the floors of many European caves.

Altogether ten culture-stages of prehistoric man are recognised by archæologists; they are, beginning with the latest:—

10.	Iron Age.	
9.	Copper and Bronze Age.	
8.	Neolithic.	
7.	Azilian.	? Transition.
6.	Magdalenian,	Younger Palæolithic.
5.	Solutrian,	
4.	Aurignacian.	
3.	Mousterian,	Older Palæolithic.
2.	Acheulian,	
1.	Chellean.	

Each of the above stages is characterised by distinctive artifacts and many of them by the presence of human remains, especially throughout the later stages, though in the older Palæolithic deposits human remains are rare. Till comparatively recently, the oldest race known was Neanderthal man, of whom numerous remains have been found in Mousterian deposits, first at Neanderthal and subsequently elsewhere. This race differed remarkably from modern man (*H. sapiens*) and is regarded as a distinct species (*H. neanderthalensis*). The subsequent discovery, near Heidelberg, of a jaw of a still more primitive type and, at Piltdown in Sussex, of a cranium also regarded as more primitive than the Neanderthal remains, has led to the establishment of a third species for the former (*H. heidelbergensis*) and even of a new genus (*Eoanthropus*) for the latter; but the generic value of *Eoanthropus* has been questioned by W. K. Gregory, who has recently published in the Bulletin of the American Museum of Natural History for 1916 an exhaustive critical discussion of the evolution of the primates; he comes to the conclusion that the Piltdown skull (*Eoanthropus dawsoni*) should be retained in the genus *Homo*, and also suggests the possibility of its identity with Heidelberg man.

With the possible exception of the Heidelberg and Piltdown fragments, no fossil remains of man are known before the Mousterian, the stage which was characterised by the presence of Neanderthal man. This stage corresponds with the third Glacial epoch, while the preceding (second) Interglacial epoch comprises the two earliest stages, the Chellean and Acheulian, the deposits of which have yielded primitive implements but no human remains. Unfortunately, the horizons from which the Heidelberg and Piltdown fragments were derived have not been determined beyond the possibility of dispute. If, as has been maintained, the deposits in which they are found belong to the first Interglacial epoch, they are clearly much older than the Mousterian man of Neanderthal and carry the records of the human race back almost to the beginning of the Pleistocene. Claims have been made for the existence of Tertiary man, but none can yet be regarded as substantiated. Those claims are based on the presence of supposed human implements (eoliths) and on the remains of certain animals said to have essentially human characters. The human origin of the supposed implements (eoliths) is still a matter of controversy, while the supposed sub-human remains are those of *Pithecanthropus erectus* found by Dubois in upper Tertiary deposits in Java and *Sivapithecus indicus* from the Siwalik rocks of India. W. K. Gregory suggests that the former may be related to man as well as to the anthropoid apes. The species *Sivapithecus indicus* was recently created by Dr. Pilgrim for certain teeth and part of a jaw from Lower Siwalik (Miocene) beds in the Punjab; he regarded those remains as human in type, as may be seen from his reconstruction of the lower jaw. W. K. Gregory, however, takes a different view, and the question is still the subject of controversy. The existence of Miocene man cannot therefore be taken as proved, while the Pliocene *Pithecanthropus* of Java, though possibly intermediate between man and the apes, cannot either be regarded as human. Thus the first unequivocal human remains of which the age is known exactly are Pleistocene. J. Barrell, in his analysis of the geological evidence, concludes that the period which has elapsed since the beginning of the Pleistocene epoch is at least one million, and possibly as much as 1½ million years, and we may thus take the date of Neanderthal man as from half to three-quarters of a million years ago.

It is generally agreed that modern man (*H. sapiens*) is not the direct descendant of the Neanderthal race, but is a collateral branch. W. K Gregory suggests that both may be descended from the Heidelberg type (*H. heidelbergensis*), but too little is known of the latter to permit of any certain deductions being drawn, while, to go back further still, *Pithecanthropus* of Java, which is attributed to the Pliocene, is also regarded as a collateral branch from the main stem of the human family. The view now generally adopted is that, although the anthropoid apes and man are descended from a common ancestor, the human stem (*Hominidæ*) branched off from the simian during the Tertiary epoch, not later probably than the middle of the Miocene period, or from thirteen to sixteen million years ago. So far we can only trace the line back for about ¾ million years from the present day, but if, as some maintain, the gravels in which the Piltdown skull was found are early Pleistocene, this will carry us back another half million years or so, but even that will be only a small step towards the recognition of the earliest members of the human family.

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The President announced the election of Officers and Members of Council for the year 1919 to be as follows:—

President.

Mahamahopadhyaya Haraprasad Shastri, C.I.E., M.A., F.A.S.B.

Vice-Presidents.

The Hon. Justice Sir Asutosh Mukhopadhyaya, Kt., C.S.I., D.L., D.Sc., F.R.S.E., F.A.S.B.
The Hon. Mr. F. J. Monahan, I.C.S.
Lieut.-Col. W. D Sutherland, M.D., F.A.S.B., I.M.S.
G. C. Simpson, Esq., D.Sc., F.R.S.

Secretary and Treasurer.

General Secretary:—W. A. K. Christie, Esq., B.Sc., Ph.D.
Treasurer:—R. D. Mehta, Esq., C.I.E.

Additional Secretaries.

Philological Secretary :—The Hon. Mr. Abdulla Al Ma'mun Suhrawardy, Iftikharul Millat, M.A., Ph.D., F.A.S.B.

Natural History Secretaries.
- Biology :—S. W. Kemp, Esq., B.A., F.A.S.B.
- Physical Science :—Sir P. C. Ray, Kt., C.I.E., D.Sc., Ph.D., F.A.S.B.

Anthropological Secretary :—N. Annandale, Esq., D.Sc., C.M.Z.S., F.L.S., F.A.S.B.

Joint Philological Secretary :—Mahamahopadhyaya Satis Chandra Vidyabhusana, M.A., Ph.D., F.A.S.B.

Medical Secretary :—Lieut.-Col. D. McCay, M.D., F.A.S.B., I.M.S.

Honorary Librarian :—The Hon. Justice Sir Asutosh Mukhopadhyaya, Kt., C.S.I., D.L., D.Sc., F.R.S.E., F.R.A.S., F.A.S.B.

Other Members of Council.

A. H. Harley, Esq., M.A.
H. G. Graves, Esq., A.R.S.M.
G. H. Tipper, Esq., M.A., F.G.S., F.A.S.B.
P. J. Brühl, Esq., I.S.O., D.Sc., F.C.S., F.G.S., F.A.S.B.
D. R. Bhandarkar, Esq., M.A.
F. H. Gravely, Esq., D.Sc., F.A.S.B.
The Hon. Mr. J. G. Cumming, C.S.I., C.I.E., I.C.S.

The President also announced the election of Fellows to be as follows :—

John Coggin Brown, Esq., O.B.E., M.I.M.E., F.C.S.
W. A. K. Christie, Esq., B.Sc., Ph.D.
D. R Bhandarkar, Esq., M A.
Capt. R. B. Seymour Sewell, I.M.S.

The Meeting was then resolved into the Ordinary General Meeting.

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LIST OF MEMBERS

OF THE

ASIATIC SOCIETY OF BENGAL

ON THE 31ST DECEMBER, 1918.

LIST OF OFFICERS AND MEMBERS OF COUNCIL OF THE ASIATIC SOCIETY OF BENGAL FOR THE YEAR 1918.

President.

H. H. Hayden, Esq., C.S.I., C.I.E., D.Sc., B.A., B.A.I., B.E., F.G.S., F.A.S.B., F.R.S.

Vice-Presidents.

The Hon'ble Justice Sir Asutosh Mukhopadhyaya, Kt., C.S.I., D.L., D.Sc., F.R.S.E., F.R.A.S., F.A.S.B.
Lieut.-Col. Sir Leonard Rogers, Kt., C.I.E., M.D., B.S., F.R.C.P., F.R.C.S., F.A.S.B., F.R.S., I.M.S.
Mahāmahopādhyāya Haraprasād Shāstri, C.I.E., M.A., F.A.S.B.
N. Annandale, Esq., D.Sc., C.M.Z.S., F.L.S., F.A.S.B.

Secretary and Treasurer.

General Secretary :—W. A. K. Christie, Esq., B.Sc., Ph.D.
Treasurer :—R. D. Mehta, Esq., C.I.E.

Additional Secretaries.

Philological Secretary :—The Hon. Mr. A. Al-Ma'mūn Suhrawardy, Iftikhārul Millat, M.A., Ph.D., Bar.-at-Law.
Natural History Secretaries.
- Biology :—S. W. Kemp, Esq., B.A., F.A.S.B.
- Physical Science :—P. C. Ray, Esq., C.I.E., D.Sc.

Anthropological Secretary :—N. Annandale, Esq., D.Sc., C.M.Z.S., F.L.S., F.A.S.B.
Joint Philological Secretary :—Mahāmahopādhyāya Satis Chandra Vidyābhusana, M.A., Ph.D., F.A.S.B.
Medical Secretary :—Major D. McCay, M.D., I.M.S.
Honorary Librarian :—The Hon. Justice Sir Asutosh Mukhopadhyaya, Kt., C.S.I., D.L., D.Sc., F.R.S.E., F.R.A.S., F.A.S.B.

Other Members of Council.

The Hon'ble Mr. F. J. Monahan, I.C.S.
A. H. Harley, Esq., M.A.
H. G. Graves, Esq., A.R.S.M.
G. H. Tipper, Esq., M.A., F.G.S., F.A.S.B.
P. J. Brühl, Esq., I.S.O., D.Sc., F.C.S., F.G.S., F.A.S.B.
Lieut.-Col. W. D. Sutherland, M.D., F.A.S.B., I.M.S.
D. R. Bhandarker, Esq., M.A.

LIST OF ORDINARY MEMBERS.

R.=Resident. N.R.=Non-Resident. A.=Absent. L.M.=Life Member.
F.M.=Foreign Member.

An Asterisk is prefixed to the names of the Fellows of the Society.

N.B.—Members who have changed their residence since the list was drawn up are requested to give intimation of such a change to the Honorary General Secretary, in order that the necessary alteration may be made in the subsequent edition. Errors or omissions in the following list should also be communicated to the Honorary General Secretary.

Members who are about to leave India and do not intend to return are particularly requested to notify to the Honorary General Secretary whether it is their desire to continue Members of the Society; otherwise, in accordance with Rule 40 of the rules, their names will be removed from the list at the expiration of three years from the time of their leaving India.

Date of Election.		
1909 Mar. 3.	N.R.	Abdul Latif, Syed, Deputy Magistrate. *Dacca.*
1917 April 4.	N.R.	Abdul Majid, B.A., M.R.A.S. *Golagunj, Lucknow.*
1894 Sept. 27.	L.M.	Abdul Wali, Khan Sahib. 23, *European Asylum Lane, Calcutta.*
1915 Feb. 3.	N.R.	Ahmad Ali Khan, Hafiz, Superintendent, Rampur State Library. *Rampur.*
1914 Feb. 4.	R.	Ali Chaudhury, The Hon. Nawab Syed Nawab. 27, *Weston Street, Calcutta.*
1903 Oct. 28.	A.	Allan, Alexander Smith, M.B. *Europe.*
1893 Aug. 31.	A.	Anderson, Lieut.-Col. Adam Rivers Steele, B.A., M.B., D.P.H., C.M.Z.S., I.M.S. *Europe (c/o India Office).*
1912 July 3.	N.R.	Andrews, Egbert Arthur, B.A. *Tooklai Experimental Station, Cinnenara P.O., Jorhat, Assam.*
1916 Feb. 2.	R.	Andrews, William Edgar, B.A. (Oxon). 11, *Loudon Street, Calcutta.*
1904 Sept. 28.	R.	*Annandale, Nelson, D.Sc., C.M.Z.S., F.L.S., F.A.S.B., Director, Zoological Survey of India. *Calcutta.*
1911 May 3.	R.	Atkinson, Albert Charles. *La Martiniere* 11, *Loudon Street, Calcutta.*
1904 July 6.	N.R.	Aulad Hasan, Sayid, *Khan Bahadur. Dacca.*
1917 April 4.	N.R.	Awati, P. R., M.A., Medical Entomologist, Central Research Institute. *Kasauli.*

Date of Election.		
1914 Mar. 4.	L.M.	Bacot, I. 31, *Quai d'Orsay, Paris.*
1870 Feb. 2.	L.M.	Baden-Powell, Baden Henry, M.A., C.I.E. *Ferlys Lodge*, 29, *Banbury Road, Oxford, England.*
1891 Mar. 4.	F.M.	Baillie, Sir Duncan Colvin, K.C.S.I., I.C.S. 89, *Queen's Gate, London.*
1918 April 3	N.R.	Ballabhdas, Dewan Bahadur, Banker and Zeminder. *Jubbulpur.*
1909 Feb. 3.	N.R.	Banerji, Charu Deb, B.A., LL.B. *Allahabad.*
1905 Mar. 1.	R.	Banerji, Muralidhar. *Sanskrit College, Calcutta.*
1918 Feb 6	N.R.	Banerji, Narendra Nath, Supdt. of Telegraphs. *Nagpur.*
1907 Jan. 2.	N.R.	Banerji, Rakhal Das, M.A., Supdt., Archaeological Survey. *Western Circle, Poona.*
1918 Dec. 4.	R.	Banerji, Sudhangsu Kumar, Ghose Prof. of Applied Mathematics, *Calcutta University. Calcutta.*
1885 Nov. 4.	R.	Barman, Damodar Das. 55, *Clive Street, Calcutta.*
1898 Mar. 2	N.R.	Barnes, Herbert Charles, M.A., I.C.S., Deputy Commissioner, Naga Hills. *Kohima, Assam.*
1916 Sept. 27.	A.	Basdekas, Rev. Hilarion (*c/o Curate of the Greek Church, Calcutta*).
1909 July 7.	N.R.	Bazuz, Rangnath Khunraj. *Girgaon, Bombay.*
1895 July 3.	L.M.	Beatson-Bell, The Hon. Mr. Nicholas Dodd, B.A., C.I.E., I.C.S., Chief Commissioner of Assam. *Shillong.*
1907 Feb. 6.	N.R.	Bell, Charles Alfred, C.M.G., I.C.S. *Gangtok, Sikkim.*
1915 April 7.	N.R.	Belvalkar, Sripad Krishna, M.A., Ph.D., Prof. of Sanskrit, Deccan College. *Poona.*
1909 April 7.	R.	Bentley, Charles A., M.B., D.P.H. *Writers' Building, Calcutta.*
1876 Nov. 15.	F.M.	*Beveridge, Henry, F.A.S.B., I.C.S. (retired). *Pitfold, Shottermill, Haslemere, Surrey, England.*
1917 Aug. 1.	R.	Bhandarkar, Devadatta Ramkrishna, M.A. 16, *Lansdowne Road, Calcutta.*
1908 Nov. 4.	N.R.	Bhattacharji, Bisvesvar, Deputy Magistrate, Krishnagar. *Nadia.*
1909 July 7.	R.	Bhattacharji, Shib Nath, M.B. 17, *Mohonbagan Road, Calcutta.*

Date of Election.		
1917 Feb. 7.	N.R.	Biswas, Jaminikanta, Zemindar. *Cuttack.*
1893 Feb. 1.	L.M.	Bodding, Revd. P. O. *Dumka, Sonthal Parganas.*
1912 July 3.	N.R.	Bomford, Capt. Trevor Lawrence, I.M.S., M.B., B.S., M.R.C.S., L.R.C.P. (*c/o Rev. T. Bomford, C.M.S. House, Peshawar*).
1898 Feb. 2.	R.	Bose, Amrita Lal, Dramatist. 9-2, *Ram Chandra Maitra's Lane, Calcutta.*
1918 July 3	R.	Bose, Charu Chandra, Asst. Surgeon, Medical College. 52/2, *Mirzapur St., Calcutta.*
1895 Mar. 6.	R.	*Bose, Sir Jagadis Chandra, Kt., C.S.I., M.A., D.Sc., C.I.E., F.A.S.B. *Presidency College, Calcutta.*
1917 Oct. 3.	R.	Bose, Satyendra Nath, M.Sc. *University College of Science, Calcutta.*
1914 Nov. 4.	N.R.	Bose, Thakur Birendranath. *Dacca.*
1910 July 6.	N.R.	Botham, Arthur William, I.C.S. *Shillong.*
1911 Nov. 1.	A.	Boyle, Lieut. Cecil Alexander, 11th King Edward's Lancers (*c/o India Office, London*).
1908 Jan. 1.	R.	Brahmachari, Upendra Nath, M.A., M.D. 19, *Grey Street, Calcutta.*
1906 July 4.	R.	Brown, Lieut.-Col. Edwin Harold, M.D., I.M.S. (retired). 4, *Harrington Street, Calcutta.*
1907 July 3.	N.R.	Brown, John Coggin, F.G.S., M.Sc., F.C.S., Assistant Superintendent, Geological Survey of India (*c/o Geological Survey of India, Calcutta*).
1909 Oct. 6.	R.	Brown, Percy, A.R.C.A. *Government School of Art, Calcutta.*
1909 Oct. 6.	R.	*Brühl, Paul Johannes, I.S.O., D.Sc., F.C.S., F.G.S., F.A.S.B. 35, *Ballygunge Circular Road, Calcutta.*
1901 June 5.	F.M.	*Burkill, Isaac Henry, M.A., F.A.S.B. *Botanical Gardens, Singapur.*
1896 Jan. 8.	F.M.	*Burn, Richard, C.I.E., I.C.S., F.A.S.B. (*c/o Grindlay & Co.*, 54, *Parliament Street, London, S.W.*).
1913 Jan. 1.	N.R.	Burrard, Col. Sir S. G., K.C.S.I., C.S.I., F.R.S., Surveyor-General of India. *Dehra Dun.*
1900 May 2.	N.R.	Butcher, Flora, M.D. *Tanakpur, R. & K. Railway.*
1913 Apl. 2.	R.	Calder, Charles Cumming. *Royal Botanic Gardens, Sibpur, Howrah.*

Date of Election.		
1901 Mar. 6.	N.R.	Campbell, William Edgar Marmaduke, I.C.S. *Pilibhit, U.P.*
1918 June 5.	N.R.	Campbell, Major W. L., I.A., Political Officer in Sikkim. *The Residency, Gangtok, Sikkim.*
1918 July 3.	R.	Campos, J. J. 12, *Wellesley St., Calcutta.*
1912 Mar. 6.	A.	Carmichael, His Excellency the Right Hon'ble Thomas David, Baron of Skirling. G.C.I.E., K.C.M.G. (*c/o India Office, London*).
1915 Jany. 6.	R.	Carter, Humphry G., M.B., Ch.B. Economic Botanist to the Botanical Survey, Indian Museum. 27, *Chowringhee Road, Calcutta.*
1910 May 4.	A.	Carter, Capt. Robert Markham, I.M.S. *Europe* (*c/o India Office*).
1905 May 3.	R.	Chakravarti, Dwarkanath, M.A., B.L., Vakil, High Court. *Calcutta.*
1890 June 4.	N.R.	*Chakravarti, Rai Monmohan, Bahadur, M.A., B.L., F.A.S.B. *Comilla, Tipperah.*
1909 Mar. 3.	R	Chakravarti, Nilmani, M.A. *Presidency College, Calcutta.*
1905 July 5.	N.R.	Chakravarti, Vanamali. *Cotton College, Gauhati.*
1906 Jan. 3.	R.	Chapman, John Alexander, Librarian, Imperial Library. *Calcutta.*
1895 Oct. 27.	N.R.	Chatterjee, The Hon. Mr. Atul Chandra, I.C.S. *Lucknow.*
1908 Feb. 5	R.	Chatterjee, Gopal Chandra, M.B. *Medical College, Calcutta.*
1911 June 7.	R.	Chatterjee, Karuna Kumar, F.R.C.S. 74, *Dharamtola Street, Calcutta.*
1916 Jan. 5.	R.	Chatterjee, Khagendra Nath, B.A., B.L., Attorney-at-Law. 12, *Madan Mohan Chatterjee Lane, Calcutta.*
1907 Sept. 25.	R.	Chatterjee, Promode Prakas. 8, *Dixon Lane, Calcutta.*
1893 Sept 28.	R.	Chaudhuri, B. L., B.A., D.Sc. (Edin.), F.R.S.E., F.L.S. (Lond.). 120, *Lower Circular Road, Calcutta.*
1911 Mar. 1.	N.R.	Chaudhuri, Charu Chandra, Rai Bahadur, Zemindar, Sherpur Town. *Mymensingh Dist.*
1914 April 1.	R.	Chaudhuri, Gopal Das. 32, *Beadon Row,* [*Calcutta.*
1907 July 3	R.	Christie, William Alexander Kynoch, B.Sc., Ph.D., Offg. Assay Master, H.M.'s Mint. *Calcutta.*

Date of Election.		
1909 Nov. 3.	N.R.	*Christophers, Major Samuel Richmond, M.B., F.A.S.B., I.M.S., Mesopotamia Field Force, c/o *Postmaster-General, Bombay.*
1906 Nov. 7.	R.	Clarke, Geoffrey Roth, I.C.S., Offg. Director-General, Posts and Telegraphs. *Calcutta.*
1915 Sep. 1.	R.	Cleghorn, Maude Lina West, F.L.S., F.E.S. 12, *Alipur Road, Calcutta.*
1908 Nov. 4.	A.	Cook, Capt. Lewis, I.M.S. *Europe* (c/o *India Office*).
1907 July 3.	R.	Cotter, Gerald de Purcell, B.A., F.G.S., Assistant Superintendent, Geological Survey of India. *Calcutta.*
1876 Mar. 1.	F.M.	Crawfurd, James, B.A., I.C.S. (retired). *Thornwood, Uddington, Lanarkshire, Scotland.*
1887 Aug. 25.	R.	Criper, William Risdon, F.C.S., F.I.C., A.R.S.M. *Konnagar, E.I.R.*
1895 July 3.	R.	Cumming, The Hon. Mr. John Ghest, C.S.I., C.I.E., I.C.S. 3, *Loudon Street, Calcutta.*
1873 Dec. 3.	F.M.	Dames, Mansel Longworth, I.C.S. (retired). *Ventnor, Wodeland Road, Guildford, Surrey, England.*
1918 April 3.	N.R.	Das, Jagannath, Ratnakar, B.A., Private Secy. to Srimati Maharani of Ajodhya. *The Rajsadan, Ajodhya.*
1915 Sep. 1.	R.	Das-Gupta, Hem Chandra, M.A., F.G.S., Prof., Presidency College. *Calcutta.*
1896 Mar. 4.	L.M.	Das-Gupta, Jogendra Nath, B.A. (Oxon), Barrister-at-Law. 38/2, *Lower Circular Road, Calcutta.*
1916 Dec. 6.	R.	Dasji, Sri Baman, Kaviraj, Ayurvedic and Unani Physician. 152, *Harrison Road, Calcutta.*
1912 April 3.	N.R.	Das, Kasi Nath, Prof., Ravenshawe College. *Cuttack.*
1917 April 4.	R.	Datta, Rasik Lal, D.Sc., Asst. Professor, Calcutta University. 78, *Manicktola St., Calcutta.*
1910 Jan. 5.	R.	David, David A. 55, *Free School St., Calcutta.*
1895 Sept. 19.	N.R.	De, Kiran Chandra, B.A., I.C.S., Commissioner. *Chittagong.*
1900 Dec. 5.	R.	Deare, Lieut.-Col. Benjamin Hobbs, M.R.C.S. (Eng.), L.R.C.P. (Lond.), D.P.H. (Cantab), I.M.S. 14, *Russell Street, Calcutta.*

Date of Election.		
1917 June 6.	R.	Deb, Kumar Harit Krishna, M.A., Zemindar, Sobhabazar Rajbati. *Raja Navakrishna St., Calcutta.*
1904 Sept. 28.	N.R.	De Courcy, William Blennerhasset. *Leddlesdale Estate, Naduwatum P.O., Nilgiris.*
1912 May 1.	A.	Demetriadi, Stephen. *Europe* (*c/o Ralli Bros., Calcutta*).
1906 Dec. 5.	N.R.	Dentith, Arthur William, I.C.S. *Shillong.*
1916 Dec. 6.	R.	Dharmapala, Anagarika, Secretary, Mohabodhi Society. 4*a*, *College Square, Calcutta.*
1910 May 4.	L.M.	Dhavle, Sankara Balaji, I.C.S. *Lahiria Sarai, Darbhanga.*
1907 Oct. 30.	N.R.	Dixit, Sri Ram, B.A., *Dewan of Banswara, Rajputana.*
1898 Jan. 5.	R.	Dods, William Kane, Agent, Hongkong and Shanghai Banking Corporation. *Calcutta.*
1909 Nov. 3.	N.R.	*Donovan, Lieut.-Col. Charles, M.D., I.M.S., F.A.S.B. *Medical College, Madras.*
1917 Mar. 7.	N.R	Dousamdup, Kazi, B.B. School. *Gangtok, Sikkim.*
1902 July 2.	R.	Doxey, Frederick. 9, *Queen's Park, Ballygunge, Calcutta.*
1909 Aug. 4.	N.R.	Drake-Brockman, Digby Livingstone, I.C.S. *Saharanpur, U.P.*
1912 April 3.	N.R.	Duff-Sutherland-Dunbar, Capt. Sir George, Bart. 19th *Punjabis, Hyderabad, Sind.*
1917 June 6.	R.	Dunn, T. O. D., Educational Service. *United Service Club. Calcutta.*
1914 Sept. 2.	R.	Dutt, B. C. 172, *Manicktola Street, Calcutta.*
1916 May 3.	N.R.	Dutt, Dharanidhar, B.A. *Nepal.*
1877 Aug. 30.	R.	Dutt, Kedar Nath. 1, *Sikdarpara Lane, Calcutta.*
1910 April 6.	A.	Ebden, Capt. F. T. P., 73*rd Carnatic Infantry. Europe* (*c/o India office*).
1910 April 6.	R.	Elmes, Dr. Cecil H. 9/4, *Middleton Row, Calcutta.*
1911 Nov. 1.	R.	Esch, V. J., Architect. *Victoria Memorial Building, Cathedral Avenue, Maidan, Calcutta.*
1904 Aug. 3.	R.	*Fermor, Lewis Leigh, A.R.S.M., D.Sc., F.G.S., F.A.S.B., Superintendent, Geological Survey of India. *Calcutta.*
1916 June 7.	R.	Ferrer, Joseph Orlando, Cuban Consul. 6, *Ezra Mansions, Calcutta.*

Date of Election.		
1906 Oct. 31.	N.R.	Finlow, Robert Steel, Fibre Expert to the Govt. of Assam. *Dacca.*
1907 Mar. 6.	R.	Firminger, The Ven'ble Walter Kelly, M.A., B.D., F.R.G.S., Archdeacon of Calcutta. *St. John's House, Council House Street, Calcutta.*
1910 Sept. 7.	A.	Fortescue, Capt. Archer Irvine, R.A.M.C. *Europe* (*c/o Army Dept.. Simla*).
1913 Nov. 5.	N.R.	Fox, Lieut. Cyril S. (*c/o Geological Survey of India, Calcutta*).
1910 April 6.	A.	Francis, Lieut. Reginald Frankland, Indian Army. *Europe* (*c/o India Office*).
1903 Mar. 4.	R.	*Gage, Lieut.-Col. Andrew Thomas, M.A., M.B., B.Sc., F.L.S., F.A.S.B. I.M.S. *Royal Bot. Gardens, Calcutta.*
1893 Jan. 11.	N.R.	*Gait, His Honour Sir Edward Albert, K.C.S.I., C.S.I., C.I.E., F.A.S.B. I.C.S., Lieutenant-Governor of Bihar and Orissa. *Ranchi.*
1912 Mar. 6.	R.	Ganguli, Manmohan, B.E., District Engineer. *Mirzapur Street, Calcutta.*
1909 Oct. 7.	R.	Ganguli, Ordhendhu Kumar. 12, *Ganguli's Lane, Calcutta.*
1916 May 3.	A.	Geuns, M. van. *Europe.*
1918 Feb. 6.	R.	Ghosh, Ekendra Nath, M.D., M.Sc. Prof. of Biology, Medical College. *Calcutta.*
1905 July 5.	R.	Ghosh, Amulya Charan, *Vidyabhusana.* 82, *Manicktolla Street, Calcutta.*
1912 Aug. 7.	R.	Ghosh, Atal Behari, M.A., B.L. 59, *Sukea Street, Calcutta.*
1918 July 3	R.	Ghose, Jnanendra Mohan, Bar.-at-Law. 1, *Harington Street, Calcutta.*
1907 Mar. 6.	R.	Ghosh, Prafulla Chundra, M.A. *Presidency College, Calcutta.*
1869 Feb. 3.	N.R.	Ghosh, Pratapa Chandra, B.A. *Vindyachal.*
1912 Sept. 4.	R.	Ghosh, Tarapada. 14, *Paddapuker Street, Kidderpur, Calcutta.*
1913 Dec. 3.	A.	Godson, Capt. Charles Aubery, I.M.S. *Europe* (*c/o India Office*).
1907 Mar. 6.	R.	Goenka, Roormall. 57, *Burtolla Street. Calcutta.*
1909 Jan. 6.	A.	Gourlay, William Robert, C.I.E., I.C.S. *Europe* (*c/o India Office*).
1910 Sept. 7.	R.	*Gravely, Frederic Henry, D.Sc., F.A.S.B., Assistant Superintendent, Zoological Survey of India. *Calcutta.*

Date of Election.		
1905 May 3.	R.	Graves, Henry George, A.R.S.M. 1, *Council House Street, Calcutta.*
1910 Nov. 2.	N.R.	Graves-Law, H. D., I.C.S. Special Asstt. to the Resident in Kashmir. *Srinagar.*
1910 Mar. 2.	A.	*Greig, Major Edward David Wilson, M.B., F.A.S.B., I.M.S. *Europe* (*c/o India Office*).
1900 Dec. 5.	L.M.	Grieve, James Wyndham Alleyne, Deputy Conservator of Forests. *Jalpaiguri.*
1917 Feb. 7.	R.	Guha, Regina, B.A., B.L. 9, *Marquis St., Calcutta.*
1917 June 6.	N.R.	Gupta, Kisorimohan, M.A., Prof. of History, M.C. College. *Sylhet, Assam.*
1915 Aug. 4.	R.	Gurner, C. W., I.C.S. *United Service Club, Calcutta.*
1901 Mar. 6.	N.R.	Habibur Rahman Khan, Raees. *Bhikanpur, District Aligarh.*
1892 Jan. 6.	F.M.	Haig, Lieut.-Col. T. Wolseley, C.M.G., Indian Army. H. B. M.'s Consulate Genl., *Isfahan, Persia.*
1907 Aug. 7.	N.R.	*Haines, Henry Haselfoot, F.C.H., F.L.S., F.A.S.B. *Ranchi.*
1908 June 3.	R.	Hallowes, Kenneth Alexander Knight, B.A., A.R.S.M., F.G.S., Assistant Superintendent, Geological Survey of India. *Calcutta.*
1916 Jan. 5.	R.	Hamilton, C. J., 9, Middleton Street, Calcutta.
1885 Feb. 4.	L.M.	*Haraprasad Shastri, Mahamahopadhyaya, C.I.E., M.A., F.A.S.B. 26, *Pataldanga Street, Calcutta.*
1902 Dec. 3.	N.R.	Harnarain Goswami, Shastri. *Hindu College, Delhi.*
1912 May 1.	R.	Harley, A. H., M.A. *Madrassa, Calcutta.*
1906 Dec. 5.	A.	Harris, Lieut. G., 56*th Infantry, F.F.* (*c/o India Office, London*).
1908 April 1	N.R.	Harrison, Edward Philip, Ph.D., F.R.S.E. *Sialkot.*
1916 Feb. 2.	R.	Hashmi, Mohammad Yusuf, M.A. *Madrassa, Calcutta.*
1897 Feb. 3.	R.	*Hayden, Henry Herbert, C.I.E., D.Sc., B.A., B.E., B.A.I., F.G.S., F.A.S.B., Director, Geological Survey of India. *Calcutta.*
1911 June 7.	R.	Hedayat Husain, Muhammad. 7-1, *Ramsanker Roy's Lane, Calcutta.*
1908 June 3.	N.R.	Heron, Alexander Macmillan, B.Sc., F.G.S., Assistant Superintendent, Geological Survey of India. (*c/o Geological Survey of India, Calcutta*).

Date of Election.		
1911 April 5.	N.R.	Hiralal, Rai Bahadur, B.A., M.R.A.S. *Damoh, C.P.*
1908 April 1.	A.	Hirst, Captain Frederick Christian. *Indian Army (c/o Survey of India).*
1891 July 1.	N.R.	*Holland, Sir Thomas Henry, K.C.I.E., D.Sc., A.R C.S., F.G.S., F.R.S., F.A.S.B., President, Indian Munitions Board. *Simla*
1908 July 1.	A.	Holmwood, The Hon. Mr. Justice Herbert, I.C.S. *Europe (c/o India Office).*
1910 Jan. 5.	R.	Hope, Geoffroy D., B.Sc., Ph.D 27, *Chowringhee Road, Calcutta.*
1914 Feb. 4.	R.	Hornell, The Hon. Mr. W. W. *Bengal Club, Calcutta.*
1873 Jan. 2.	L.M.	Houstoun, George L., F.G.S. *Johnstone Castle, Renfrewshire, Scotland.*
1918 Feb. 6.	R.	Hui, Rev. Sramana Wan. 22, *Wellesley 2nd Lane, Calcutta.*
1911 Feb. 1.	R.	Insch, Jas. 101, *Clive Street, Calcutta.*
1918 April 3.	R.	Ironside, The Hon. Mr. W. A. 2, *Woodburn Park, Calcutta.*
1915 April 7.	N.R.	Ishak Khan, Mahomed. *M. A. O. College, Aligarh.*
1904 Jan. 6.	N.R.	Jackson. Victor Herbert, M.A. *Patna College, Bankipur.*
1916 Jan. 5.	N.R	Jain, Kumar Devendra Prasad, Secy. All-India Jain Association. *Arrah.*
1907 Dec. 4.	A.	James, Henry Rosher, M.A., Bengal Education Service. *Europe (c/o India Office).*
1907 Sept. 25.	R.	Jenkins, Owen Francis, I.C.S. 1, *Council House Street, Calcutta.*
1908 June 3.	R.	Jones, Herbert Cecil, A.R.S.M., A.R.C.S., F.G.S. *Assistant Superintendent, Geological Survey of India, Calcutta.*
1911 Sept. 1.	N.R.	Juggarao, Sree Raja Ankitam Venkata. *Zemindar of Shermahamadpuram, Dabagardens, Vizagapatam.*
1911 Nov. 1.	A.	Kamaluddin Ahmed, Shams-ul-Ulama. *Europe (c/o Govt. Madrassa, Chittagong).*
1891 Feb. 4.	N.R.	Kapur, Raja Ban Behari, C.S.I. *Burdwan.*
1915 Oct. 27.	N.R.	Kaushala, Ram Sawrupa. *Ambala City.*
1918 July 3.	R.	Kazunobu, Kanokoge, Prof. of Philosophy, The Keio University, *c/o Japanese Consulate, 7, Loudon St., Calcutta.*
1911 Jan. 1.	N.R.	Kaye, George Rusby. *Registrar, Bureau of Education, Simla.*

Date of Election.		
1910 May 4.	R.	*Kemp, Stanley W., B.A., F.A.S.B., Superintendent, Zoological Survey of India. *Calcutta.* [*Mozufferpur.*
1882 Mar. 1.	N.R.	Kennedy, Pringle, M.A., B.L., Vakil.
1906 Aug. 1.	R.	Kennedy, William Willoughby, M.A., M.D., D.P.H., M.R.S.C., L.R.C.P. 10, *Harrington St., Calcutta.*
1906 Sept. 19.	R.	Kesteven, The Hon. Mr. Charles Henry, Solicitor to Government. 26, *Dalhousie Square, Calcutta.*
1918 April 3.	N.R.	Khanna, Ram Nath, c/o Mr. B. Dhani Ram. *Gurgaon.*
1909 April 7.	R.	Kilner, John Newport, M.B., L.R.C.S., L.R.C.P. 14, *Garden Reach, Calcutta.*
1910 Mar. 2.	R.	Kirkpatrick, W. *Chartered Bank Buildings, Calcutta.*
1914 April 1.	N.R.	Laddu, Tukaram Krishna. *Queen's College, Benares.*
1918 Feb. 6.	N.R.	Laiq Ahmad Ansari, Shaikh, Historical Research Office. *Bhopal.*
1887 May 4.	L.M.	Lanman, Charles Rockwell. 9, *Farrar Street, Cambridge, Massachusetts, U.S. America.*
1889 Mar. 6.	L.M.	*La Touche, Thomas Henry Digges, B.A., F.G.S., F.A.S.B. *Alfriston Hills Road, Cambridge, England.*
1914 Aug. 5.	R.	Law, Bimala Charan, B.A. 24, *Sukea St., Calcutta.*
1911 Feb. 1.	R.	Law, Narendra Nath, M.A., B.L.. 96, *Amherst St., Calcutta.*
1914 July 1.	R.	Law, Satya Charan, M.A., B.L. 24, *Sukea St., Calcutta.*
1902 July 2.	N.R.	Leake, Henry Martin, M.A., F.L.S. *Nawabgunj, Cawnpore.*
1918 June 5.	R.	Lees, W. H., I.C.S., Commissioner, Burdwan Dn. *Chinsurah.*
1911 May 3.	R.	Lomax, C.E., M.A. 11, *Loudon Street, Calcutta.*
1906 Oct. 31.	N.R.	Luard, Capt. Charles Eckford, M.A. (Oxon), Indian Army. *Nimach.*
1870 April 7.	L.M.	Lyman, B. Smith. 708, *Locust Street, Philadelphia, U.S. America.*
1905 Aug. 2.	R.	McCay, Lt.-Col. David, M.D., I.M.S. *Medical College, Calcutta.*
1916 July 5.	N.R.	MacKenna, J., I.C.S., Agricultural Adviser to the Government of India. *Pusa.*

Date of Election.		
1893 Jan. 11.	L.M.	Maclagan, The Hon. Sir Edward Douglas, M.A., K.C.I.E., C.S.I., I.C.S., Secretary, Government of India, Education Department. *Simla.*
1912 May 1.	R.	McLean, David. *Chowringhee Mansions, Calcutta.*
1913 Mar. 5.	A.	MacMahon, P. S. *Europe* (*c/o Canning College, Lucknow*).
1893 Jan. 11.	L.M.	Madho Rao Scindia, His Highness Maharajah Colonel Sir, *Alijah Bahadur,* G.C.S.I., G.C.V.O., A.D.C., LL.D., Maharajah of Gwalior. *Jai Bilas, Gwalior.*
1916 June 7.	N.R.	Mahajan, Surya Prasad. *Murarpur, Gaya.*
1906 Dec. 5.	R.	Mahalanobis, Subodh Chandra, B.Sc., F.R.S.E., F.R.M.S. 210, *Cornwallis Street, Calcutta.*
1911 Mar. 1.	R.	Mahatap, The Hon. Sir Bijoy Chand, K.C.S.I., Maharajadhiraj of Burdwan. 6, *Alipur Lane, Calcutta.*
1898 Nov. 2.	N.R.	Maitra, Akshaya Kumar, B.A., B.L. *Rajshahi.*
1918 Aug. 7.	R.	Maitra, Jatindra Nath, Physician and Surgeon, 68/*a, Beadon St., Calcutta.*
1918 Feb. 6.	N.R.	Maitra, Sisir Kumar, Principal, Indian Institute of Philosophy. *Amalner ,Bombay Presidency.*
1918 Feb. 6.	N.R.	Manen, Johan van. *Balaclava Hotel, Ghoom, D.H. Ry.*
1901 June 5.	N.R.	Mann, Harold Hart, D.Sc., M.Sc., F.L.S., Principal, Agricultural College. *Poona.*
1907 Dec. 4.	N.R.	Manners-Smith, Lieut.-Col. John, C.V.O., C.I.E., Indian Army. *Resident, Kashmir.*
1899 Aug. 30.	N.R.	Mannu Lal, Rai Bahadur, Retired Civil Surgeon. *Rai Bareli.*
1905 Dec. 6.	F.M.	Marsden, Edmund, B.A., F.R.G.S. 12, *Elerdale Road, Hampstead, London.*
1916 Feb. 2.	R.	Majumdar, Narendra Kumar, M.A., Asst. Prof. Calcutta University. *Calcutta.*
1912 Jan. 10.	N.R.	Mazumdar, Rai Jadunath, Bahadur, Government Pleader. *Jessore.*
1913 June 4.	R.	Mazumdar, Ramesh Chandra, M.A., 16, *Chandranath Chatterji Street, Bhowanipur, Calcutta.*
1917 May 2.	A.	Meerwarth, Dr. A. M. *Europe.*
1886 Mar. 3.	L.M.	Mehta, Roostumjee Dhunjibhoy, C.I.E. 9, *Rainey Park, Ballygunge, Calcutta.*
1884 Nov. 5.	N.R.	*Middlemiss, Charles Stewart, B.A., F.G.S., F.A.S.B. *Kashmir, Srinagar.*

Date of Election.		
1884 Sept. 3.	R.	Miles, William Harry. 21, *Old Court House Street, Calcutta.*
1912 June 5.	N.R.	Misra, Champaram. *Partabgarh, Oudh*
1911 July 5.	N.R.	Misra, Rai Bahadur Pandit Shyam Behari, B.A., I.C.S., Deputy Collector. *Unao, Oudh.* [*Calcutta.*
1916 Nov. 1.	R.	Mitra, Adar Chandra, B.L. *Bow Street,*
1906 June 6.	R.	Mitra, Kumar Manmatha Nath. 34, *Shampukur Street, Calcutta.*
1915 Jan. 6.	R.	Mitra, Prakash Chandra, Engineer and Contractor. 16*a*, *Amherst Street, Calcutta.*
1909 May 5.	N.R.	Mohyuddin Ahmad, Abul-Kalam, Azad. *Ranchi.* [*habad.*
1901 Aug. 7.	N.R.	Molony, Edmund Alexander, I.C.S. *Alla-*
1895 July 3.	R.	Monahan, The Hon. Mr. Francis John, I.C.S. *Harrington Mansions, Calcutta.*
1906 Dec. 5.	N.R.	More, Major James Carmichael. 51st Sikhs. (*c/o Presidency Post Master, Bombay*).
1908 Dec. 2.	A.	Moses, Capt. Owen St. John, M.D., F.R.C.S., I.M.S. *Europe* (*c/o India Office*).
1912 Jan. 10.	R.	Muhammad Kazim Shirazi, Aga. 23, *Lower Chitpur Road, Calcutta.*
1909 Mar. 3.	R.	Mukerjee, Brajalal, M.A. 12, *Old Post Office Street, Calcutta.*
1899 Sept. 29.	R.	Mukerjee, Jotindra Nath, B.A., Solicitor. 3, *Old Post Office Street, Calcutta.*
1916 Mar. 1.	R.	Mukerjee, Prabhat Kumar, Bar.-at-Law. 14*a*, *Ramtanoo Bose Lane, Calcutta.*
1898 May 4.	R.	Mukerjee, Sir Rajendra Nath, K.C.I.E. 7, *Harrington Street, Calcutta.*
1894 Aug. 30.	R.	Mukerjee, Sibnarayan. *Uttarpara, Bally.*
1886 May 5.	L.M.	*Mukhopadhyaya, The Hon. Justice Sir Asutosh, Kt., C.S.I., M.A., D.L., D.Sc., F.R.S.E., F.R.A.S., F.A.S.B., Judge, High Court. *Calcutta.*
1908 Feb. 5.	R.	Mukhopadhyaya, Girindra Nath, B.A., M.D. 156, *Haris Mukerjee Road, Bhowanipur, Calcutta.*
1892 Dec. 7.	R.	Mukhopadhyaya, Panchanan. 46, *Bechoo Chatterji's Street, Calcutta.*
1910 Nov. 2.	A.	Murray, William Alfred, B.A. (Cantab), M.B. *Europe* (*c/o Assam-Bengal Railway, Chittagong*).
1906 Mar. 7.	R.	Nahar, Puran Chand. 48, *Indian Mirror Street, Calcutta.*

Date of Election.		
1918 Sept. 25.	N.R.	Narayan, Prince Victor N. *Cooch Bihar.*
1916 July 5.	R.	Naseer Hosein Khankhayab, Syed. 78, *Prinsep St., Calcutta.*
1917 Mar. 7.	N.R.	Newton, Rev. R. P., M.A., Chaplain, Bengal Ecclesiastical Establishment. *Dinapur.*
1901 Mar. 6.	N.R.	Nevill, Lieut.-Col. Henry Rivers, I.C.S., Army Headquarters. *Delhi.*
1889 Aug. 29.	L.M.	Nimmo, John Duncan. *c/o Messrs. Walter Duncan & Co.,* 137, *West George Street, Glasgow.*
1913 July 2	N.R.	Norton, E. L., I.C.S., District Magistrate. *Orient Club Building, Chowpatti, Bombay.*
1908 Feb. 5.	A.	Nott, Lieut.-Col. Arthur Holbrook, M.D., I.M.S. *Europe* (*c/o India Office*).
1916 Feb. 2.	A.	Oka, Rev. R. *c/o Bangae & Co. Europe.*
1906 Dec. 5.	R.	O'Kincaly, Lieut.-Col. Frederick, M.R.C.S., (Eng.), L.R.C.P. (Lond.), I.M.S. *Presidency General Hospital, Calcutta.*
1915 April 7.	R.	Otani, Count Kozui. *c/o Consulate-General of Japan, Calcutta.*
1907 July 3.	A.	Page, William Walter Keigley. *Europe* (*c/o Pugh & Co., Calcutta*).
1901 Jan. 2.	N.R.	Pande, Ramavatar, B.A., I.C.S., District Judge. *Mirzapur, U.P.*
1904 Aug. 3.	N.R.	Parasnis, Rao Bahadur Dattalraya Balwant. *Satara.*
1910 April 6.	N.R.	Patuck, Pestonji Sorabji, I.C.S. *Narsinghpur.*
1906 Dec. 5.	N.R.	Peart, Major Charles Lubé. 106*th Hazara Pioneers, Quetta.*
1916 July 5.	N.R.	Pease, Col. H. T., C.I.E., M.R.C.V.S. *Veterinary College, Lahore.*
1888 June 6.	L.M.	Pennell, Aubray Percival, B.A., Bar.-at-Law. *Rangoon.*
1877 Aug. 1.	N.R.	Peters, Lieut.-Col. Charles Thomas, M.B., I.M.S. (retired). *Dinajpur.*
1915 May 5.	A.	Philby, H. St. J. B., I.C.S. *Europe* (*c/o Alliance Bank, Calcutta*).
1889 Nov. 6.	L.M.	*Phillott, Lieut.-Colonel Douglas Craven, Ph.D., F.A.S.B. *Indian Army (retired).* c/o Messrs. Grindlay & Co., 54, *Parliament Street, London.*
1914 Nov. 4.	R.	Pickford Alfred Donald. 12, *Mission Row, Calcutta.*
1904 June 1.	N.R.	Pilgrim, Guy Ellcock, D.Sc., F.G.S. (*c/o Geological Survey of India, Calcutta*).

Date of Election.		
1910 Aug. 3.	R.	Podamraj Jain, Raniwalla. 9, *Joggomohan Mullick's Lane, Calcutta.*
1918 April 3.	R.	Prasad, Baini, D.Sc., Supdt. of Fisheries, Bengal, Bihar and Orissa. *Indian Museum, Calcutta.*
1914 Mar. 4.	A.	Raffin, Alain. *Europe.*
1880 April 7.	N.R.	Rai, Bepin Chandra. *Giridih, Chota Nagpur.*
1895 Aug. 29.	N.R.	Rai Chaudhuri, Jatindranath M.A., B.L., Zemindar. *Taki, Jessore.*
1908 Feb. 5.	N.R.	Randle, Herbert Neil, B.A. *Queen's College, Benares.*
1917 June 6.	N.R.	Rangaswami Aiyangar, K. V., Rao Bahadur, Prof. of History and Economics, H.H. The Maharaja's College. *Trivandrum.*
1905 Jan. 4.	N.R.	Rankin, James Thomas, I.C.S. *Dacca.*
1904 Mar. 4.	F.M.	Rapson, E. J. 8, *Mortimer Road, Cambridge.*
1890 Mar. 5.	R.	*Ray, Sir Prafulla Chandra, Kt., D.Sc., F.A.S.B., Professor, Presidency College. *Calcutta.*
1917 May 2.	R.	Ray, Dr. Kumud Sankar, M.A., B.Sc., M.B., Ch.B (Edin.). 44, *European Asylum Lane, Calcutta.*
1905 May 3.	R.	Richardson, The Hon. Mr. Justice Thomas William, I.C.S. 21, *Belvedere Road, Calcutta.*
1918 April 3.	F.M.	Robinson, Herbert C., Director of Museums and Fisheries, Federated Malay States. *Kuala Lumpur.*
1913 Sept. 3.	A.	Rogalsky, P. A. *Europe (c/o Imperial Russian Consulate General, Calcutta).*
1900 April 4.	R.	*Rogers, Lt.-Col. Sir Leonard, Kt., C.I.E., M.D., B.S., F.R.C.P., F.R.C.S., F.A.S.B., F.R.S., I.M.S. *Medical College, Calcutta.*
1901 Dec. 4.	F.M.	*Ross, Sir Edward Denison, Kt., C.I.E., Ph.D., F.A.S.B., Director, School of Oriental Studies. *London.*
1918 July 3.	R.	Roy, Dr. Bidhan Chandra, M.D., F.R.C.S., M.R.C.P,, (Lond.), Lecturer, Campbell Medical School. 36, *Wellington St., Calcutta.*
1889 June 5.	N.R.	Roy, Maharaja Girijanath. *Dinagepore.*
1903 July 1.	L.M.	Roy, Maharaja Jagadindranath, *Bahadur.* 6, *Lansdowne Road, Calcutta.*
1915 Oct. 27.	R.	Roy, Kaviraj Jamini Bhusan, M.A., M.B. 46, *Beadon St., Calcutta.*

Date of Election.		
1910 Sept. 7.	N.R.	Roy, Kumar Sarat Kumar. *Dayarampur, Rajshahi.*
1909 Nov. 3.	N.R.	Roychaudhury, Mritunjoy. *Shyampur P.O., Rungpur.*
1917 Oct. 3.	R.	Saha, Meghnad. M.Sc., University College of Science. *Calcutta.*
1916 April 5.	N.R.	Saha, Radha Nath. 16, *Lachmikundu, Benares City.*
1913 Apl. 2.	N.R.	Sahay, Rai Sahib Bhagvati, M.A., B.L., Offg. Inspector of Schools, Patna Division. *Bankipur.*
1911 Nov. 1.	N.R.	Sahni, Dayaram, M.A., Supdt. of Archæology. *Jammu, Kashmir.*
1916 July 5.	R.	Sarkar, Ganpati. 69, *Baliaghata Main Road, Calcutta.*
1898 Mar. 2.	N.R.	Sarkar, Jadunath. Hindu University. *Benares City.*
1909 Mar. 3.	R.	Sarvadhikari, Sir Deva Prasad, Kt., C.I.E., M.A., B.L. 2, *Old Post Office Street, Calcutta.*
1911 Jan. 4.	R.	Sarvadhikari, Dr. Suresh Prasad. 79-1, *Amherst St., Calcutta.*
1917 Dec. 5.	R.	Sastri, Ananta Krishna, Pandit. 56/1*a*, *Sri Gopal Mallick Lane, Calcutta.*
1902 June 4.	R.	*Satis Chandra Vidyabhusana, Mahamahopadhyaya, M.A., Ph.D., F.A.S.B. 28/1, *Kanay Lal Dhar's Lane, Calcutta.*
1900 Dec. 5.	A.	Schwaiger, Imre George, Expert in Indian Art. *Europe.*
1915 Feb. 3.	R.	Segard, Dr. C. P. 23, *Park Mansions, Calcutta.*
1902 May 7.	R.	Sen, Jogendra Nath, *Vidyaratna*, M.A. 31, *Prasanna Kumar Tagore's Street, Calcutta.*
1914 April 1.	N.R.	Sen-Gupta, Dr. Nares Chandra. *Dacca.*
1897 Dec. 1.	R.	Seth, Mesrovb J. 19, *Lindsay Street, Calcutta.*
1911 July 5.	N.R.	Sewell, Capt. Robert Beresford Seymour, M.R.C.S., L.R.C.P., I.M.S. 1/141, *Bikaner Infantry, Bikaner.*
1909 Jan. 6.	N.R.	Shirreff, Alexander Grierson, B.A., I.C.S. Secy. Govt. of U.P. *Allahabad.*
1913 Dec. 3.	R.	Shorten, Capt. James Alfred, B.A., M.B., B Ch., I.M.S. *Medical College, Calcutta.*
1914 Mar. 4.	R.	Shrosbree, A. de Bois. *Improvement Trust, Calcutta.*

Date of Election.		
1908 Mar. 4.	R.	Shujaat Ali, Nasirul Mamalik Mirza, Khan Bahadur, Acting Consul-General for Persia. 10, *Hungerford Street, Calcutta.*
1916 Aug. 2.	N.R.	Shukla, Pandit Ashwani Kumar, B.A., LL.B., Revenue Officer, Mewar State. *Udaipur.*
1902 Feb. 5.	N.R.	Shyam Lal, Lala, M.A., LL.B., Deputy Collector. *Naimadri, Agra.*
1899 May 3.	N.R.	Silberrad, Charles Arthur, B.A., B.Sc., I.C.S., *Gorakhpur, U.P.*
1913 Mar. 5.	N.R.	Simonsen, J. L., D.Sc., *Presidency College, Madras.* [*Simla.*
1909 April 7.	N.R.	*Simpson, George Clarke, D.Sc., F.A.S.B.
1918 Feb. 6	N.R.	Singh, Badakaji Marichiman. 38, *Khichapokhari, Katmandu, Nepal.*
1894 July 4.	N.R.	Singh, Raja Kushal Pal, M.A. *Narki.*
1912 May 1.	R.	Singh Roy, Rai Lalit Mohan, Bahadur. 4, *Creek Row, Calcutta.*
1893 Mar. 1.	N.R.	Singh, Maharaja Kumara Sirdar Bharât, I.C.S. (retired). *Shankergar, Allahabad.*
1899 Aug. 29.	N.R.	Singh, H.H. The Maharâja Sir Prabhu Narain, Bahadur, G.C.I.E., Maharaja of Benares. *Ramnagar Fort, Benares.*
1909 April 7.	N.R.	Singh, Raja Prithwipal, Talukdar of Surajpur. *District Barabanki, Oudh.*
1899 Nov. 6.	L.M.	Singh, H.H. The Hon. Maharaja Sir Rameshwara, Bhahadur, K.C.I.E. *Durbhanga.* [*now.*
1913 July 2.	N.R.	Singh, Rudradat, M.A., LL.B., Vakil. *Luck-*
1894 Feb. 7.	N.R.	Singh, H.H. The Maharaja Vishwa Nath, Bahadur. *Chhatturpur, Bundelkhund.*
1918 Feb. 6	R.	Singha, Kumar Arun Chandra, M.A. 120/3, *Upper Circular Road, Calcutta.*
1918 April 3.	N.R.	Sinha, Raja Bahadur Bhupendra Narayan, B.A. *Nasipur Rajbati, Nasipur P.O.*
1912 Sept. 5.	N.R.	Singhi, Bahadur Singh. *Azimgunj, Murshidabad.*
1897 Jan. 6.	R.	Sircar, Amrita Lal, F.C.S., L.M.S. 51, *Sankaritolla Lane, Calcutta.*
1898 Aug. 3.	N.R.	Sita Ram, Lala, B.A., Depy. Magistrate. *Allahabad.*
1913 July 2.	N.R.	Sivaprasad, B.A., Offg. Junior Secretary to the Board of Revenue, U.P. *Allahabad.* [*India Office*).
1911 Mar. 2.	A.	Smith, Major O. A. 27th Punjabis (c/o
1901 Dec. 4.	N.R.	*Spooner, David Brainard, B.A., Ph.D., F.A.S.B. *Simla.*

Date of Election.		
1904 Sept. 28.	A.	Stapleton, Henry Ernest, B.A., B.Sc. *Europe (c/o India Office).*
1908 Dec. 2.	R.	Steen, Major Hugh Barkley, M.B., I.M.S. 6, *Harrington Street, Calcutta.*
1900 Aug. 29.	N.R.	Stephenson, Lieut.-Col. John, D.Sc., M.B., F.R.C.S., I.M.S. *Lahore.*
1907 Dec. 4.	R.	Stevens, Lieut.-Col. C. R., I.M.S. *Medical College, Calcutta.*
1907 June 5	A.	Stewart, Capt. Francis Hugh, I.M.S. *Europe (c/o India Office).*
1906 Dec. 5.	A.	Stokes, Captain Claude Bayfield. *Europe (c/o India Office).*
1915 April 7.	N.R.	Storey, C. A., Prof. of Arabic, M. A. O. College. *Aligarh.*
1916 July 5.	R.	Street, W. S. *Shaw Wallace & Co., Calcutta.*
1907 Aug. 7.	N.R.	Subramania Iyer, Valavanur, Extra Asst. Conservator of Forests. *Quilon, Travancore.*
1907 June 5.	R.	Suhrawardy, The Hon. Mr. Abdullah Al-Ma'mūn, Iftikharul Millat, M.A., D.Litt., LL.D., Bar.-at-Law. 3, *Wellesley 1st Lane, Calcutta.*
1914 Mar. 4.	R.	*Sutherland, Lt.-Col. William Dunbar, F.A.S.B., I.M.S. 5, *Theatre Road, Lane, Calcutta.*
1916 Sept. 27.	N.R.	Sutherland, Rev. W. S., D.D., Scottish Universities Mission. *Kalimpong, Darjeeling Dist.*
1907 June 5.	A.	Swinhoe, Rodway Charles John. *Europe (c/o High Court, Rangoon).*
1909 Jan. 6.	R.	Tagore, Kshitindranath, B.A. 6/1, *Dwarkanath Tagore Lane, Calcutta.*
1914 April 1.	R.	Tagore, Prafulla Nath. 1, *Darpanarain Tagore Street, Calcutta.*
1898 April 6.	R.	Tagore, The Hon. Maharaja Sir Prodyat Coomar, Bahadur, Kt. *Pathuriaghatta, Calcutta.*
1904 July 6.	F.M.	Talbot, Walter Stanley, I.C.S. c/o Messrs. H. S. King & Co. 9, *Pall Mall, London, S.W.*
1910 Aug. 3.	N.R.	Tancock, Capt. Alexander Charles. 31*st Punjabis, Nowshera, N.W.F.P.*
1893 Aug. 31.	N.R.	Tate, George Passman. 56, *Cantonment, Bareilly, U.P.*
1906 Dec. 5.	N.R.	Tek Chand, Dewan, B.A., M.R.A.S., I.C.S., Deputy Commissioner. *Gujranwala, Punjab.*

Date of Election.		
1878 June 5.	F.M.	Temple, Colonel Sir Richard Carnac, Bart., C.I.E., Indian Army. 9, *Pall Mall, London.*
1914 Aug. 5.	N.R.	Tessitori, Dr. L. P. *Bikaner, Rajputana.*
1911 Mar. 1.	F.M.	Thomas, F. W., M.A., Ph.D., Librarian, India Office. *London.*
1909 Aug. 4.	N.R.	Thompson, John Perronet, M.A., I.C.S. Chief Secretary, *Government of the Panjab, Lahore.*
1908 Nov. 4.	A.	Thornely, Major Michael Harris, I.M.S. *Europe* (*c/o India Office*).
1911 July 5.	A.	Thurston, Capt. Edward Owen, I.M.S., B.S., F.R.C.S. *Europe* (*c/o India Office*).
1904 June 1.	N.R.	*Tipper, George Howlett, M.A., F.G.S., F.A.S.B., Assistant Superintendent, Geological Survey of India. *Calcutta.*
1912 Nov. 6.	R.	Tomkins, H. G., C.I.E., F.R.A.S., Accountant General, Bengal. *Calcutta.*
1907 Feb. 6.	A.	*Travers, Morris William, D.Sc., F.R.S., F.A.S.B. (43, *Warwick Gardens, London, W.*)
1861 June 5.	L.M	Tremlett, James Dyer, M.A., I.C.S. (retired). *Dedham, Essex, England.*
1917 Dec. 5.	N.R.	Tripathi, Ramprasad, Reader in Modern Indian History. *The University, Allahabad.*
1894 Sep. 27.	R.	Vasu, Nagendra Nath. 20 *Visvakosh Lane, Bagbazaar, Calcutta.*
1900 Aug. 29.	A.	Vaughan, Lieut.-Col. Joseph Charles Stoelke, I.M.S. *Europe* (*c/o India Office*).
1901 Mar. 6.	F.M.	*Vogel, Jean Philippe, Litt.D., F.A.S.B. *The University, Leiden, Holland.*
1894 Sept. 27.	L.M.	Vost, Lieut.-Col. William, I.M.S., Civil Surgeon. *Cantonment, Bellary.*
1902 Oct. 29.	R.	*Vredenburg, Ernest, B.L., B.Sc., A.R.S.M., A.R.C.S., F.G.S., F.A.S.B., Superintendent, Geological Survey of India. *Calcutta.*
1907 July 3.	N.R.	Walker, Harold, A.R.C.S., F.G.S., A.M. Inst.M., Assistant Superintendent, Geological Survey of India. *Calcutta.*
1918 April 3	F.M.	Wall, Lt.-Col. F., C.M.G., I.M.S. (*c/o Messrs. King, King & Co.*, 9, *Pall Mall, London.*)
1901 June 5.	N.R.	Walsh, The Hon. Mr. Ernest Herbert Cooper, C.S.I., I.C.S., Commissioner, Chota Nagpur Divn. *Ranchi.*
1911 Feb. 1.	N.R.	Waters, Dr. Harry George, F.R.I.P.H. *Allahabad.*

Date of Election.		
1905 Dec. 6.	A.	Watson, Edwin Roy, M.A., B.Sc. *Europe, (c/o Dacca College, Dacca).*
1909 Dec. 1.	N.R.	Webster, J. E., I.C.S. *Sylhet, Assam.*
1913 April 2.	R.	White, Bernard Alfred. *Chartered Bank Buildings, Calcutta.*
1915 Jany. 6.	N.R.	Whitehouse, Richard H., Prof. of Biology, Govt. College. *Lahore.*
1906 Sept. 19.	N.R.	Whitehead, Richard Bertram, I.C.S. *Rupar, Umbala, Punjab.*
1915 May 5.	N.R.	Williams, L. F. Rushbrook, B.A., B.Litt., Prof. of Modern Indian History, Allahabad University. *Allahabad.*
1909 April 7.	A.	Woodhouse, E. J., B.A. *(c/o Agricultural College, Sehour).*
1912 Mar. 6.	R.	Woodroffe, The Hon. Justice Sir John George, Kt. 4, *Camac Street, Calcutta.*
1906 Mar. 7.	N.R.	Woolner, Alfred Cooper, M.A. Punjab University. *Lahore.*
1908 April 1.	R.	Wordsworth, The Hon. Mr. William Christopher. *Writers' Buildings, Calcutta.*
1894 Aug. 30.	A.	Wright, Henry Nelson, B.A., I.C.S. *Europe. (c/o India Office).*
1911 Aug. 2.	N.R.	Young, Gerald Mackworth, B.A., I.C.S. *Lahore.*
1906 June 6.	F.M.	Young, Mansel Charles Gambier.
1910 April 6.	N.R	Young, Capt. Thomas Charles McCombie, M.B., I.M.S. *Shillong, Assam.*

SPECIAL HONORARY CENTENARY MEMBERS.

Date of Election.	
1884 Jan. 15.	Revd. Professor A. H. Sayce, Professor of Assyriology, Queen's College. *Oxford, England.*
1884 Jan. 15.	Monsieur Émile Senart. 18, *Rue François Ier, Paris, France.*

HONORARY FELLOWS.

Date of Election.	
1879 June 4.	Dr. Jules Janssen. *Observataire d'Astronomie Physique de Paris, France.*
1895 June 5.	Lord Rayleigh, M.A., D.C.L., D.Sc., LL.D., Ph.D., F.R.A.S., F.R.S. *Ferling Place, Witham, Essex, England.*
1895 June 5.	Charles H. Tawney, Esq., M.A., C.I.E. *c/o India Office, London.*
1896 Feb. 5.	Professor Charles Rockwell Lanman. 9, *Farrar Street, Cambridge, Massachusetts, U.S. America.*
1899 Feb. 1.	Dr. Augustus Frederick Rudolf Hœrnle, Ph.D., C.I.E. 8, *Northmoor Road, Oxford, England.*
1899 Dec. 6.	Professor Edwin Ray Lankester, M.A., LL.D., F.R.S. *British Museum (Nat. Hist.), Cromwell Road, London, S.W.*
1899 Dec. 6.	Professor Edward Burnett Tylor, D.C.L., LL.D., F.R.S., Keeper, University Museum. *Oxford, England.*
1901 Mar. 6.	Professor John Wesley Judd, C.B., LL.D., F.R.S., F.G.S., Late Prof. of the Royal College of Science. 30, *Cumberland Road, Kew, England.*
1904 Mar. 2.	Professor Sir Ramkrishna Gopal Bhandarkar, K.C.I.E. *Poona.*
1904 Mar. 2.	Sir Charles Lyall, M.A., K.C.S.I., C.I.E., LL.D. 82, *Cornwall Gardens, London, S.W.*
1904 Mar. 2.	Sir George Abraham Grierson, K.C.I.E., Ph.D., D.Litt., C.I.E., I.C.S. (retired). *Rothfarnham, Camberley, Surrey, England.*
1906 Mar. 7.	The Right Hon'ble Baron Curzon of Kedleston, M.A., D.C.L., F.R.S. 1, *Carlton House Terrace, London, S.W.*
1908 July 1.	Lieut.-Col. Henry Haversham Godwin-Austen, F.R.S., F.Z.S., F.R.G.S., *Nora Godalming, Surrey, England.*
1911 Sept. 6.	Lieut.-Col. Alfred William Alcock, C.I.E., M.B., LL.D., C.M.Z.S., F.R.S., I.M.S. (retd.). *Heathlands, Erith Road, Belvedere, Kent, England.*
1911 Sept. 6.	Prof. Edward George Browne, M.A., M.B., M.R.C.S., L.R.C.P., M.R.A.S. *Pembroke College, Cambridge.*
1911 Sept. 6.	Mahamahopadhyaya Kamakhyanath Tarkavagisa. 111-4, *Shambazar Street, Calcutta.*
1915 Aug. 4.	Prof. Paul Vinogradoff, F.B.A., D.C.L. 19, *Linton Road, Oxford, England.*
1915 Aug. 4.	Monsieur Jean Geston Darboux. 3, *Rue Nazarine, Paris, France.*

Date of Election.	
1915 Aug. 4.	Sir Patrick Manson, G.C.M.G., M.D., LL.D., F.R.C.P. 21, *Queen Anne Street, Cavendish Square, London, W.*
1915 Aug. 4.	Sir Joseph John Thomson, Kt., O.M., M.A., Sc.D., D.Sc., LL.D., Ph.D. *Trinity College, Cambridge, England.*
1916 Dec. 6.	Dr. G. A. Boulenger, F.R.S., LL.D., British Museum (Nat. Hist.). *Cromwell Road, London, S.W.*
1917 May 2.	Herbert A. Giles, Esq., LL.D., University of Cambridge. *Cambridge.*

FELLOWS.

Date of Election.	
1910 Feb. 2.	N. Annandale, Esq., D.Sc., C.M.Z.S., F.L.S.
1910 Feb. 2	The Hon'ble Justice Sir Asutosh Mukhopadhyaya, Kt., C.S.I., M.A., D.L., D.Sc., F.R.A.S., F.R.S.E.
1910 Feb. 2.	I. H. Burkill, Esq., M A., F.L.S.
1910 Feb. 2.	Mahamahopadhyaya Haraprasad Shastri, C.I.E., M.A.
1910 Feb. 2.	Sir Thomas Holland, K.C.S.I., K.C.I.E., D.Sc., A.R.C.S., F.G.S., F.R.S.
1910 Feb. 2.	T. H. D. LaTouche, Esq., B.A., F.G S.
1910 Feb. 2.	Rai Bahadur Monmohan Chakravarti, M.A., B.L.
1910 Feb. 2.	Lieut.-Colonel D. C. Phillott, Ph.D., Indian Army (retired).
1910 Feb. 2.	Sir Prafulla Chandra Ray, Kt., D.Sc.
1910 Feb. 2.	Lieut.-Col. Sir Leonard Rogers, Kt., C.I.E., M.D., B.S., F.R.C.P., F.R.C.S., F.R.S., I.M.S.
1910 Feb. 2.	Sir E. D. Ross, Kt., C.I.E., Ph.D.
1910 Feb. 2.	Mahamahopadhyaya Satis Chandra Vidyabhusana, M.A., Ph.D., M.R.A.S.
1910 Feb. 2.	M. W. Travers, Esq., D.Sc., F.R.S.
1911 Feb. 1.	The Hon. Sir E. A. Gait, K.C.S.I., C.S.I., C.I.E., I.C.S.
1911 Feb. 1.	H. H. Hayden, Esq., C.S.I., C.I.E., D.Sc., B.A., B.E., B.A.I., F.G.S., F.R.S.
1912 Feb. 7.	H. Beveridge, Esq., I.C.S. (retired).
1912 Feb. 7.	Sir J. C. Bose, Kt., C.S.I., C.I.E., M.A., D.Sc.
1912 Feb. 7.	P. J. Bruhl, Esq., Ph.D., F.C.S.
1912 Feb. 7.	Capt. S. R. Christophers, I.M.S.
1912 Feb. 7.	Charles Stewart Middlemiss, Esq., B.A., F.G.S.
1913 Feb. 5.	Lieut.-Col. A. T. Gage, I.M.S.

Date of Election.	
1913 Feb. 5.	E. Vredenburg, Esq., B.I., B.Sc., A.R.S.M., A.R.C.S., F.G.S.
1913 Feb. 5.	J. Ph. Vogel, Esq., Ph. D., Litt.D.
1913 Feb. 5.	S. W. Kemp, Esq. ,B.A.
1915 Feb. 3.	Major E. D. W. Greig, C.I.E., M.B., I.M.S.
1915 Feb. 3.	G. H. Tipper, Esq., M.A., F.G.S.
1915 Feb. 3.	D. B. Spooner, Esq., Ph.D.
1915 Feb. 3.	H. H. Haines, Esq., F.C.H., F.L.S.
1916 Feb. 2.	Lieut.-Col. C. Donovan, M.D., I.M.S.
1916 Feb. 2.	The Hon. Mr. R. Burn, C.I.E., I.C.S.
1916 Feb. 2.	L. L. Fermor, Esq., A.R.S.M., D.Sc., F.G.S.
1917 Feb. 7.	G. C. Simpson, Esq., D.Sc., F.R.S.
1917 Feb. 7.	Lt.-Col. W. D. Sutherland, M.D., I.M.S.
1917 Feb. 7.	F. H. Gravely, Esq., D.Sc.
1918 Feb. 6.	Colonel Sir Sidney G. Burrard, K C.S.I., F.R.S.
1918 Feb. 6.	J. L. Simonsen, Esq., Ph.D.
1918 Feb. 6.	Lt.-Col. J. Stephenson, D.Sc., I.M.S.
1918 Feb. 6.	Lieut.-Col. D. McCay, M.D., I.M.S.
1918 Feb. 6.	The Hon Mr. Abullah Al-Mámun Suhrawardy, M.A., Ph.D.

ASSOCIATE MEMBERS.

Date of Election.	
1875 Dec. 1.	Revd. J. D. Bate. 15, *St. John's Church Road, Folkestone, Kent, England.*
1885 Dec. 2.	Dr. A. Führer, Prof. of Sanskrit, 5, *Dorenbach strasse Bininngen, Basel, Switzerland.*
1899 Nov. 1.	Revd. E. Francotte, S.J. 30, *Park Street, Calcutta.*
1902 June 4.	Revd. A. H. Francke. *Europe.*
1908 July 1.	Rai Sahib Dinesh Chandra Sen, B.A. 19, *Visvakos Lane, Calcutta.*
1910 Sept. 7.	Shamsul Ulama Maulavi Ahmad Abdul Aziz. *Azeez Bag, City-Hyderabad, Deccan.*
1910 Sept. 7.	L. K. Anantha Krishna Iyer, Esq, *Trichur.*
1910 Dec. 7.	Rev. H. Hosten, S.J. 30, *Park Street, Calcutta.*
1915 Mar. 3.	E. Brunetti, Esq. 27, *Chowringhee Road, Calcutta.*
1915 Dec. 1.	Pandit Jainacharya Vijayadharma Surisvaraji, *Yasovijaya Granthamal Office, Benares City.*

LIST OF MEMBERS WHO HAVE BEEN ABSENT FROM INDIA THREE YEARS AND UPWARDS.*

* *Rule* 40.—After the lapse of three years from the date of a member leaving India, if no intimation of his wishes shall in the interval have been received by the Society, his name shall be removed from the List of Members.

The following members will be removed from the next Member List of the Society under the operation of the above Rule :—

Capt. Robert Markham Carter, I.M.S.
Stephen Demetriadi, Esq.
Capt. Charles Aubery Godson, I.M.S.
Lieut. G. Harris, I.A.
Capt. Frederick Christian Hirst, I.A.
Lieut.-Col. Arthur Holbrook Nott, M.D., I.M.S.
Major O. A. Smith, I.A
Capt. Francis Hugh Stewart, I.M.S.
Major Michael Harris Thornely, I.M.S.
Capt. Edward Owen Thurston, I M.S.

LOSS OF MEMBERS DURING 1918.

BY RETIREMENT.

Ordinary Members.

C. J. Brown, Esq.
Lieut.-Col. John Telfer Calvert, M.B., M.R.C.P., I.M.S.
P. Chaudhuri, Esq., Bar.-at-Law.
Dr. Herbert Milverton Crake.
Lt.-Col. Charles Robert Mortimer Green, M.D., F.R.C.S., I.M.S.
Babu Harendra Kumar Mukerji.
The Hon. Mr. Edward Brooks Henderson Panton, B.A., I.C.S.
Charles Gilbert Rogers, Esq., F.L.S., F.C.H.
Babu Kiran Chandra Roy.
The Hon. Surendra Nath Roy.
Capt. J. D. Sandes, M.B., I.M.S.
H. P. Watts, Esq., B.A.

Associate Members.

Dr. Ekendra Nath Ghosh.
Bada Kaji Marichiman Singha.

BY DEATH.

Ordinary Members.

Syed Abdulla-ul-Musawy, B.A.
Maharaja Ranjit Singh.
Arthur Venis, Esq., M.A., D.Litt., C.I.E., F.A.S.B.

RULE 38.

Mr. Amir Ahmad Ansari.
Babu Viresvar Bhattacharji.
Fazli Haqq, Esq.
E. H. Hankin, Esq., M.A., D.SC.
Babu Panchanan Neogi.

RULE 40.

T. H. Bishop, Esq., D.P.H.
Sir Robert Warrand Carlyle, K.C.S.I., C.I.E.
Harry Lushington Stephen, Esq., I.C.S.
Arthur L. Stonebridge, Esq.

ELLIOTT GOLD MEDAL AND CASH.

RECIPIENTS.

1893	Chandra Kanta Basu.
1895	Yati Bhusana Bhaduri, M.A.
1896	Jnan Saran Chakravarti, M.A.
1897	Sarasi Lal Sarkar, M.A.
1901	Sarasi Lal Sarkar, M.A.
1904	Sarasi Lal Sarkar, M.A.
	Surendra Nath Maitra, M.A.
1907	Akshoyakumar Mazumder.
1911	Jitendra Nath Rakshit.
	Jatindra Mohan Datta.
1913	Rasik Lal Datta.
	Saradakanta Ganguly.
	Nagendra Chandra Nag.
	Nilratan Dhar.
1918	Bibhutibhushan Dutta, M.SC.

BARCLAY MEMORIAL MEDAL.

RECIPIENTS.

1901	E. Ernest Green, Esq.
1903	Major Ronald Ross, F.R.C.S., C.B., C.I.E., F.R.S., I.M.S. (retired).

1905 Lieut.-Colonel D. D. Cunningham, F.R.S., C.I.E., I.M.S. (retired).
1907 Lieut.-Colonel Alfred William Alcock, M.B., LL.D., C.I.E., F.R.S.
1909 Lieut.-Colonel David Prain, M.A., M.B., LL.D., F.R.S., I.M.S. (retired).
1911 Dr. Karl Diener.
1913 Major William Glen Liston, M.D., C.I.E., I.M.S.
1915 J. S. Gamble, Esq., C.I.E., M.A., F.R.S.
1917 Lieut.-Colonel Henry Haversham Godwin-Austen, F.R.S., F.Z.S., F.R.G.S.

[APPENDIX.]

ABSTRACT STATEMENT

OF

RECEIPTS AND DISBURSEMENTS

OF THE

ASIATIC SOCIETY OF BENGAL

FOR

THE YEAR 1918.

STATEMENT

Asiatic Society

1918.

Dr.

	Rs.	As.	P.	Rs.	As.	P.
To Establishment.						
Salaries	6,746	0	8			
Commission	799	1	7			
Pension	197	4	9			
Grain Allowance	27	12	0			
War Bonus	207	2	6	7.977	5	6
To Contingencies.						
Stationery...	103	8	0			
Light and Fans	96	1	0			
Postage	532	4	3			
Repairs	337	13	0			
Auditing	150	0	0			
Taxes	1,495	0	0			
Insurance	343	12	0			
Petty Repairs	74	6	0			
Interest on G.P. Notes purchased ...	56	15	5			
Miscellaneous	372	13	3	3,562	8	11
To Library and Collections.						
Books	583	9	3			
Binding	191	14	0	775	7	3
To Publication.						
Journal and Proceedings, and Memoirs ...	6,210	14	0			
To printing charges of Circulars, etc. ...	263	4	3	6,474	2	3
To Personal Account (written-off)				749	0	6
Balance				1,96,833	3	3
Total Rs. ...				2,16,371	11	8

No. 1.

of Bengal. *1918.*

Cr.

	Rs.	As.	P.	Rs.	As.	P.
By Balance from last Report				1,88,429	10	6
By Cash Receipts.						
Interest on Investments	8,913	4	2			
Rent of Room	600	0	0			
Publications sold for cash	312	0	0			
Government allowance—formerly included in Anthropological Fund account—for publication of papers in the Journal	5,000	0	0			
Miscellaneous	122	1	0			
				14,947	5	2
By Personal Account.						
Members' subscription	9,191	0	0			
Subscriptions to Journal and Proceedings, and Memoirs	1,920	0	0			
Admission fees	896	0	0			
Sales on credit	904	8	9			
Miscellaneous	83	3	3			
				12,994	12	0
Total Rs. ...				2,16,371	11	8

E. & O. E.

R. D. Mehta,
Hon. Treasurer.

Calcutta, 31*st December*, 1918.

STATEMENT

1918. *Barclay Memorial Fund in Account*

From a sum of Rs. 500 odd given in 1896 by the Surgeon
couragement of Medical

Dr.

To Cash Expenditure.

	Rs. As. P.	Rs. As. P.
Printing	...	6 8 0
To Balance—		
G.P. Notes (face value)	500 0 0	
Accumulated interest	69 2 4	
		569 2 4
Total Rs. ...		575 10 4

STATEMENT

1918. *Servants' Pension*

Founded in 1876 as the Piddington Pension Fund,

Dr.

To Cash Expenditure.

	Rs. As. P.	Rs. As. P.
Pension	16 0 0	
Commission for realizing interest ...	0 4 0	
		16 4 0
Balance ...		1,568 3 10
Total Rs. ...		1,584 7 10

No. 2.

with the Asiatic Society of Bengal. *1918.*

General, I.M.S., for the foundation of a medal for the en-
and Biological Science.

Cr.

	Rs. As. P.	Rs. As. P.
By Balance from last Report—		
G.P. Notes (face value)	500 0 0	
Accumulated interest	60 3 1	
		560 3 1
By Cash Receipt.		
Interest		15 7 3
Total Rs. ...		575 10 4

E. & O. E.

R. D. Mehta,
Hon. Treasurer.

Calcutta, 31st December, 1918.

No. 3.

Fund. *1918.*

with Rs. 500 odd from the Piddington Fund.

Cr.

	Rs. As. P.
By Balance from last Report	1,535 7 10
By Cash Receipt.	
Interest	49 0 0
Total Rs. ...	1,584 7 10

E. & O. E.

R. D. Mehta,
Hon. Treasurer.

Calcutta, 31st December, 1918.

STATEMENT

1918. *Building*

From a sum of Rs. 40,000 given by the Government of

Dr.

To Cash Expenditure.

	Rs.	As.	P.
Commission for realizing interest	1	11	0
Balance	51,172	10	0
Total Rs.	51,174	5	0

STATEMENT

1918. *Catalogue of Scientific Serial Publi-* *Asiatic Society*

From a sum of Rs. 2,500 given by the Trustees of the Indian Museum

Dr.

	Rs.	As.	P.	Rs.	As.	P.
Balance				2,500	0	0
Total Rs. ...				2,500	0	0

No. 4.

Fund. *1918.*

India towards the rebuilding of the Society's Rooms.

Cr.

	Rs.	As.	P.
By Balance from last Report	49,776	0	0
BY CASH RECEIPT.			
Interest	1,398	5	0
TOTAL Rs.	51,174	5	0

E. & O. E.

R. D. MEHTA,

Hon. Treasurer.

Calcutta, 31*st December*, 1918.

No. 5.

cations, Calcutta, in Acct. with the *1918.*
of Bengal.

through the Government of India for the publication of catalogue.

Cr.

	Rs.	As.	P.	Rs.	As.	P.
By Balance from last Report				2,500	0	0
TOTAL Rs. ...				2,500	0	0

E. & O. E.

R. D. MEHTA,

Hon. Treasurer.

Calcutta, 31*st December*, 1918.

STATEMENT

1918. Indian Science Congress in Account

From the subscriptions of

Dr.

To Cash Expenditure.

	Rs.	As.	P.	Rs.	As.	P.
Printing charges	587	14	3			
Contingencies	452	5	0			
Postage	131	8	6			
Stationery	26	0	0			
Advertisement	144	0	0			
Advance	600	0	0			
Bonus	47	0	0			
Subscription	5	0	0			
				1,993	11	9
Balance				2,190	14	5
Total Rs. ...				4,184	10	2

STATEMENT

1918. International Catalogue of Scienti-
Asiatic Society

From of a sum of Rs. 1,000 given by the Government of

Dr.

To Cash Expenditure.

	Rs.	As.	P.
Salaries	302	7	6
Balance	697	8	6
Total Rs. ..	1,000	0	0

No. 6.

with the Asiatic Society of Bengal. 1918.

members of the Congress.

Cr.

		Rs. As. P.	Rs. As. P.
By Balance from last Report	...		1,946 6 2
By Cash Receipt.			
Subscription, etc.	...	2,138 4 0	
Advance	...	100 0 0	2,238 4 0
	Total Rs. ...		4,184 10 2

E. & O. E.

Calcutta, 31*st December*, 1918. R. D. Mehta, *Hon. Treasurer.*

No. 7.

fic Literature in Account with the 1918.
of Bengal.

Bengal for expenses incurred in connection of the Bureau.

Cr.

	Rs. As. P.
By Cash Receipt.	
Government Allowance	1,000 0 0
Total Rs. ...	1,000 0 0

E. & O. E.

Calcutta, 31*st December*, 1918. R. D. Mehta, *Hon. Treasurer.*

STATEMENT

1918. Oriental Publication Fund, No. 1, in

From a monthly grant made by the Government of Bengal for the publica-
(Rs. 500), and for the publication of Sanskrit

Dr.

To Cash Expenditure.

	Rs.	As.	P.	Rs.	As.	P.
Salaries	1,953	10	10			
Grain Allowance	5	4	0			
Contingencies	114	2	11			
Stationery	8	2	4			
Postage	497	14	6			
Editing	732	0	0			
Books	5	3	0			
Light and Fans	18	12	3			
Commission	100	0	5			
Printing	3,382	15	0			
Freight	3	15	3			
War Bonus	58	8	9			
				6,880	9	3
To Personal Account (written-off)				23	14	0
Balance				25,890	11	9
Total Rs. ..				32,795	3	0

STATEMENT

1918. Oriental Publication Fund, No. 2, in

From a monthly grant made up to Mar. 31, 1922, by the Government of
Historical Interest

Dr.

	Rs.	As.	P.	Rs.	As.	P.
Balance				14,109	3	0
Total Rs. ...				14,109	3	0

No. 8.

Acct. with the Asiatic Soc. of Bengal. 1918.

tion of Oriental Works and Works on Instruction in Eastern Languages
Works hitherto unpublished (Rs. 250).

Cr.

	Rs.	As.	P.	Rs.	As.	P.
By Balance from last Report				17,081	13	0
By Cash Receipts						
Government Allowance	9,000	0	0			
Publications sold for cash	805	9	6			
Advances recovered	125	9	0	9,931	2	6
By Personal Account.						
Sales on credit	3,346	4	6	...		
Printing	2,435	15	0	5,782	3	6
Total Rs.				32,795	3	0

E. & O. E.

Calcutta, 31st *December*, 1918.

R. D. Mehta, *Hon. Treasurer.*

No. 9.

Acct. with the Asiatic Soc. of Bengal. 1918.

Bengal of Rs. 250 for the publication of Arabic and Persian Works of
(without remuneration).

Cr.

	Rs.	As.	P.
By Balance from last Report	9,109	3	0
By Cash Receipt.			
Government Allowance	5,000	0	0
Total Rs.	14,109	3	0

E. & O. E.

Calcutta, 31st *December*, 1918.

R. D. Mehta, *Hon. Treasurer.*

STATEMENT

1918. Oriental Publication Fund, No. 3, in

From special non-recurring grants made by the Government of Bengal
English translation of the Akbar-

Dr.

To Cash Expenditure.

	Rs.	As.	P.
Printing charges	387	1	0
Balance	397	9	6
Total Rs. ...	784	10	6

STATEMENT

1918. Bureau of Information in Account

From an annual grant of Rs. 1,200, made by the Govern-

Dr.

To Cash Expenditure.

	Rs.	As.	P.
Salary	1,200	0	0
Balance ...	1,000	0	0
Total Rs. ...	2,200	0	0

No. 10.

Acct. with the Asiatic Soc. of Bengal. 1918.

in 1908 of Rs. 3,000 and in 1914 of Rs. 2,000, for the publication of an nama (without remuneration).

Cr.

	Rs.	As.	P.
By Balance from last Report	784	10	6
TOTAL Rs. ...	784	10	6

E. & O. E.

Calcutta, 31*st December*, 1918. R. D. MEHTA, *Hon. Treasurer.*

No. 11.

with the Asiatic Society of Bengal. 1918.

ment of Bengal for the salary of the Officer-in-Charge.

Cr.

	Rs.	As.	P.
By Balance from last Report	1,000	0	0
BY CASH RECEIPT.			
Government Allowance	1,200	0	0
TOTAL Rs. ...	2,200	0	0

E. & O. E.

R. D. MEHTA,

Calcutta, 31*st December*, 1918. *Hon. Treasurer.*

STATEMENT

1918. *Anthropological Fund in Account*

From an annual grant of Rs. 2,000, made by the Government of

Dr.

To Cash Expenditure.	Rs.	As.	P.	Rs.	As.	P.
Printing	16	14	0			
Govt. Allowance (transferred to Society's Fund) Account	5,000	0	0	5,016	14	0
Balance				1,052	4	0
Total Rs. ...				6,069	2	0

STATEMENT

1918. *Sanskrit Manuscript Fund in Acct.*

From annual grants of Rs. 3,200, made by the Government of Bengal
krit Manuscripts acquired by the Society for Government; and Rs. 2,400

Dr.

To Cash Expenditure.				Rs.	As.	P.
Salaries	1,639	11	9			
Bonus	420	0	0			
Grain Allowance	3	0	0			
Salary of Officer-in-Charge	2,400	0	0			
Contingencies	17	7	2			
Stationery...	11	12	4			
Light and Fans	21	5	6			
Insurance	125	0	0	4,638	4	9
Balance				7,918	13	0
Total Rs. ...				12,557	1	9

No. 12.

with the Asiatic Society of Bengal. *1918.*

Bengal, for the publication of papers in the Journal.

Cr.

			Rs.	As.	P.
By Balance from last Report	... ...		4,069	2	0
BY CASH RECEIPT.					
Government Allowance	... ...		2,000	0	0
	TOTAL RS.	...	6,069	2	0

E. & O. E.
R. D. MEHTA,
Hon. Treasurer.

Calcutta, 31st December, 1918.

No. 13.

with the Asiatic Society of Bengal. *1918.*

and at present sanctioned to Mar. 31, 1923, for the cataloguing of Sans-
from the same Government for the salary of the Officer-in-Charge.

Cr.

					Rs	As.	P.
By Balance from last Report					6,915	10	9
BY CASH RECEIPT.							
Government Allowance for Cataloguing ...	2,400	0	0				
" " " Sans. MS. Preservation ...	3,200	0	0				
Publication sold for cash	25	8	0				
Advances recovered	0	7	0				
					5,625	15	0
BY PERSONAL ACCOUNT.							
Sale on credit					15	8	0
TOTAL RS. ...					12,557	1	9

E. & O. E.
R. D. MEHTA,
Hon. Treasurer.

Calcutta, 31st December, 1918.

STATEMENT

1918. *Arabic and Persian MSS. Fund in*

From an annual grant of Rs. 5,000, made by the Government of India
binding of Arabic and Persian Manuscripts acquired by the Society
preparation of notices of Arabic and Persian manu-

Dr.

To Cash Expenditure.

	Rs.	As.	P.	Rs.	As.	P.
Salaries	3,630	15	3			
Grain Allowance	3	0	0			
Binding	8	4	0			
Purchase of MSS.	114	0	0			
Contingencies	33	14	8			
Stationery	15	14	4			
Postage	5	2	0			
Insurance	31	4	0			
				3,842	6	3
Balance				8,227	14	4
Total Rs. ...				12,070	4	7

STATEMENT

1918. *Invest-*

Dr.

	Face Value. Rs.	As.	P.	Cost. Rs	As.	P.
To Balance from last Report	2,59,300	0	0	2,56,163	8	10
,, Purchase	25,000	0	0	17,042	11	0
Total Rs. ...	2,84,300	0	0	2,73,206	3	10

Funds.	Permanent Reserve.						Temporary Reserve						Total		
	Face Value.			Cost.			Face Value.			Cost.					
	Rs.	A.	P.	Rs.	A.	P.	Rs	A	P.	Rs.	A.	P.	Rs.	A.	P.
Asiatic Society ...	1,68,500	0	0	1,67,185	9	8	74,400	0	0	66,596	4	2	2,33,781	13	10
Building Fund ...	40,000	0	0	38,025	0	0	...	..	...	...	...	...	38,025	0	0
Servants' Pension Fund	1,400	0	0	1,399	6	0	...	...	...	...	...	..	1,399	6	0
Total Rs. ...	2,09,900	0	0	2,06,609	15	8	74,400	0	0	66,596	4	2	2,73,206	3	10

No. 14.

Acct. with the Asiatic Soc. of Bengal. *1918.*

and at present sanctioned to March 31st, 1919, only, for the cataloguing and for Government, for the purchase of further manuscripts, and for the scripts found in various libraries in India.

Cr.

	Rs.	As.	P.
By Balance from last Report	7,070	4	7
By Cash Receipt.			
Government Allowance	5,000	0	0
Total Rs. ...	12,070	4	7

E. & O. E.

Calcutta, 31*st December*, 1918. R. D. Mehta, *Hon. Treasurer.*

No. 15.

ment. *1918.*

Cr.

	Face Value. Rs.	As.	P.	Cost. Rs.	As.	P.
By Balance	2,84,300	0	0	2,73,206	3	10
Total Rs. ...	2,84,300	0	0	2,73,206	3	10

E. & O. E.

Calcutta, 31*st December*, 1918. R. D. Mehta, *Hon. Treasurer.*

STATEMENT

1918. *Treasury*

Dr.

	Rs.	As.	P.	Rs.	As.	P.
To Balance from last report :—						
Bills for 12 months from 1st December 1917, Rs. 15,000	14,250	0	0			
Bills for 6 months from 1st December 1917, Rs. 5,000	4,878	2	0			
				19,128	2	0
To Purchase :—						
Bills for 3 months from 22nd April 1918, Rs. 20,000	19,750	0	0			
Bills for 3 months from 1st June 1918, Rs. 5,000	4,943	12	0			
Bills for 6 months from 3rd October 1918, Rs. 5,000	4,887	8	0			
Bills for 6 months from 2nd December 1918, Rs. 15,000 ...	14,634	6	0			
Bills for 12 months from 17th December 1918, Rs. 5,000	4,750	0	0			
				48,965	10	0
TOTAL ...				68,093	12	0

STATEMENT

1918. *Fixed*

Dr.

	Rs.	As.	P.
To deposit for 6 months from 15th June, 1918, @ 3½% per annum	5,000	0	0
TOTAL Rs. ...	5,000	0	0

No. 16.

Bills. *1918.*

Cr.

	Rs. A. P.	Rs. As. P.
By Bank of Bengal	4,878 2 0	
,, Do.	19,750 0 0	
,, Do.	4,943 12 0	
,, Do.	14,250 0 0	
		43,821 14 0
By Balance		24,271 14 0
Total Rs. ...		68,093 12 0

E. & O. E.

Calcutta, 31*st December*, 1918.

R. D. Mehta, *Hon. Treasurer.*

No. 17.

Deposit. *1918.*

Cr.

	Rs. As. P.
By Bank of Bengal	5,000 0 0
Total Rs. ...	5,000 0 0

E. & O. E.

R. D. Mehta,

Hon. Treasurer.

Calcutta, 31*st December*, 1918.

STATEMENT

1918. *Personal*

Dr.

	Rs. As. P.	Rs. As. P.
To Balance from last Report	...	3,792 3 11
Advances for postage, etc.	344 6 0	
To Asiatic Society	12,994 12 0	
,, Oriental Publication Fund, No. 1 ...	5,782 3 6	
,, Sanskrit Manuscript Fund	15 8 0	
		19,136 13 6
TOTAL Rs. ...		22,929 1 5

STATEMENT

1918. *War*

Dr.

	Rs. As. P.	Rs. As. P.
To Purchase	...	5,000 0 0
TOTAL Rs. ...		5,000 0 0

No. 18.

Account. *1918.*

Cr.

		Rs	As.	P.
By Cash Receipts	... ...	18,294	10	8
" Asiatic Society	... ...	749	0	6
,, Oriental Publication Fund, No. 1	... ...	23	14	0

By Balance.	Due to the Society.			Due by the Society.		
	Rs.	As.	P.	Rs.	As.	P.
Members ...	3,784	11	9	52	8	6
Subscribers ...	...	...	...	48	0	0
Ujagir Chaube (Bill Collector) ...	...	...	...	100	0	0
Miscellaneous ...	315	9	0	38	4	0
	4,100	4	9	238	12	6

		Rs	As.	P.
	...	3,861	8	3
TOTAL RS.	...	22.929	1	5

E. & O. E.

R. D. MEHTA,
Hon. Treasurer.

Calcutta, 31*st December*, 1918.

No. 19.

Bond. *1918.*

Cr.

		Rs. As. P.	Rs.	As.	P.
By Bank of Bengal ...	... ...		5,000	0	0
TOTAL RS.	...		5,000	0	0

E. & O. E.

R. D. MEHTA,
Hon. Treasurer.

Calcutta, 31*st December*, 1918.

STATEMENT

1918. *Cash*

Dr.

	Rs.	As.	P.	Rs.	As.	P.
To Balance from last Report	...			11,694	8	8
,, Asiatic Society	14,947	5	2			
,, Barclay Memorial Fund	15	7	3			
,, Servants' Pension Fund	49	0	0			
,, Building Fund	1,398	5	0			
,, Indian Science Congress	2,238	4	0			
,, International Catalogue of Scientific Literature	1,000	0	0			
,, Oriental Publication Fund, No. 1 ...	9,931	2	6			
,, Do. Do. No. 2 ...	5,000	0	0			
,, Bureau of Information	1,200	0	0			
,, Sanskrit MSS. Fund	5,625	15	0			
,, Anthropological Fund	2,000	0	0			
,, Arabic and Persian MSS. Fund ...	5,000	0	0			
,, Treasury Bills	43,821	14	0			
,, Personal Account	18,294	10	8			
,, Fixed Deposit	5,000	0	0			
				1,15,521	15	7
TOTAL RS. ...				1,27,216	8	3

No. 20

Account. *1918.*

Cr.

	Rs.	As.	P.	Rs.	As.	P.
By Asiatic Society	18,856	10	2			
,, Barclay Memorial Fund	6	8	0			
,, Servants' Pension Fund	16	4	0			
,, Building Fund	1	11	0			
,, Indian Science Congress	1,993	11	9			
,, International Catalogue of Scientific Literature	302	7	6			
,, Oriental Publication Fund, No. 1 ...	6,880	9	3			
,, Do. Do. No. 3 ...	387	1	0			
,, Bureau of Information ...	1.200	0	0			
,, Sanskrit MSS. Fund	4,638	4	9			
,, Anthropological Fund	5,016	14	0			
,, Arabic and Persian MSS. Fund ...	3,842	6	3			
,, Investment	17,042	11	0			
,, Treasury Bills	48,965	10	0			
,, Fixed Deposit	5,000	0	0			
,, War Bond	5,000	0	0			
,, Personal Account	344	6	0			
				1,19.428	0	5
*Balance				7,788	7	10
Total Rs. ...				1.27,216	8	3

	Rs.	A.	P.
*Bank of Bengal	6,339	6	9
Alliance Bank	69	2	4
Cash in hand	4	10	9
,, with Jamadar	30	0	0
Cheque in hand	1,345	4	0
Total Rs. ...	7,788	7	10

E. & O. E.

R. D. Mehta,
Hon. Treasurer.

Calcutta, 31*st December*, 1918.

STATEMENT

1918. *Balance*

LIABILITIES.

	Rs. As. P.	
Asiatic Society Capital Fund	1,96,833 3 3	
Barclay Memorial Fund	569 2 4	
Servants' Pension Fund	1,568 3 10	
Building Fund	51,172 10 0	
Catalogue of Scientific Serial Publications, Calcutta	2,500 0 0	
Indian Science Congress	2,190 14 5	
International Catalogue of Scientific Literature	697 8 6	
Oriental Publication Fund, No. 1 ...	25,890 11 9	
Do. Do. No. 2 ...	14,109 3 0	
Do. Do. No. 3 ...	397 9 6	
Bureau of Information	1,000 0 0	
Sanskrit MSS. Fund	7,918 13 0	
Anthropological Fund	1,052 4 0	
Arabic and Persian MSS. Fund	8,227 14 4	
Subscriptions, etc., paid in advance ...	138 12 6	
		3,14,266 14 5
Sundry deposits as security by Society's Officers, viz —		
Treasurer	500 0 0	
Collector	100 0 0	
		600 0 0
TOTAL Rs. ...		3,14,866 14 5

We have examined the Books and Vouchers of the Asiatic Society of Bengal for the year ended 31st December, 1918, and hereby certify that the foregoing Balance Sheet correctly sets forth the position of the Society as at that date according to the best of our knowledge and the information furnished to us.

Lindlie Chambers,
6, Hastings Street,
CALCUTTA,
10*th April*, 1919.

VINEY & THURSTON,
Chartered Accountants, Auditors.

No. 21.

Sheet. As at 31st December. *1918.*

ASSETS.

	Rs.	As	P.	Rs.	As.	P.
Investment	2,73,206	3	10			
Do. in respect of Treasurer's security	500	0	0			
Treasury Bills	24,271	14	0			
War Bond	5,000	0	0			
Personal Account	4,100	4	9			
				3,07,078	6	7
Cash Account	......			7,788	7	10
TOTAL Rs. ...				3.14,866	14	5

E. & O. E.

R. D. MEHTA,
Hon. Treasurer.

Calcutta, 31*st December*, 1918.

STATEMENT

1918. *Balance*

LIABILITIES.

	Rs.	As.	P.	Rs.	As.	P.
Asiatic Society Capital Fund	1,96,833	3	3			
Barclay Memorial Fund	569	2	4			
Servants' Pension Fund	1,568	3	10			
Building Fund	51,172	10	0			
Catalogue of Scientific Serial Publications, Calcutta	2,500	0	0			
Indian Science Congress	2,190	14	5			
International Catalogue of Scientific Literature	697	8	6			
Oriental Publication Fund, No. 1 ...	25,890	11	9			
Do. Do. No. 2 ...	14,109	3	0			
Do. Do. No. 3 ...	397	9	6			
Bureau of Information	1,000	0	0			
Sanskrit MSS. Fund	7,918	13	0			
Anthropological Fund	1,052	4	0			
Arabic and Persian MSS. Fund	8,227	14	4			
Subscriptions, etc., paid in advance ...	138	12	6			
				3,14,266	14	5
Sundry deposits as security by Society's Officers, viz —						
Treasurer	500	0	0			
Collector	100	0	0			
				600	0	0
TOTAL Rs. ...				3,14,866	14	5

We have examined the Books and Vouchers of the Asiatic Society of Bengal for the year ended 31st December, 1918, and hereby certify that the foregoing Balance Sheet correctly sets forth the position of the Society as at that date according to the best of our knowledge and the information furnished to us.

Lindlie Chambers,
6, *Hastings Street,*
CALCUTTA,
10*th April*, 1919.

VINEY & THURSTON,
Chartered Accountants, Auditors.

No. 21.

Sheet. As at 31st December. *1918.*

ASSETS.

	Rs.	As	P.	Rs.	As.	P.
Investment	2,73,206	3	10			
Do. in respect of Treasurer's security	500	0	0			
Treasury Bills	24,271	14	0			
War Bond	5,000	0	0			
Personal Account	4,100	4	9			
				3,07,078	6	7
Cash Account	......			7,788	7	10
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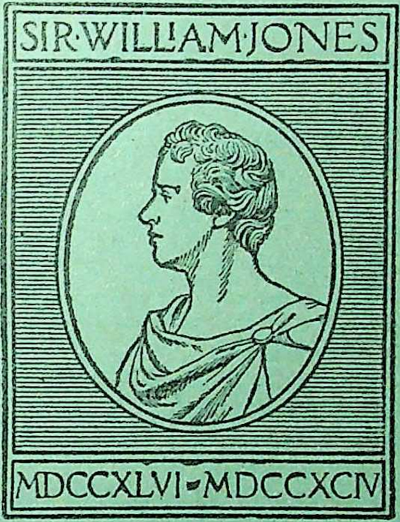
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5. A Note on Buddhaghosa's Commentaries.

By Bimala Charan Law, M.A., M.R.A.S.

Introduction.

Tradition ascribes to Thera Buddhaghosa the authorship of several exegetical works, which, as we have them now, are headed by the encyclopaedic Visuddhimagga. He is said to have written commentaries on the whole of the Vinaya Piṭaka including the Pātimokkha, the four Nikāyas, and on the seven books of the Abhidhamma-Piṭaka. The commentaries on some of the important books of the Khuddaka Nikāya are also attributed to him. Regarding Buddhaghosa, Mrs. Rhys Davids says: "It may readily be granted that Buddhaghosa must not be accepted *en bloc.* The distance between the constructive genius of Gotama and his apostles as compared with the succeeding ages of epigoni needs no depreciatory criticism on the labours of the exegesists to make itself felt forcibly enough. Buddhaghosa's philology is doubtless crude and he is apt to leave the cruces unexplained, concerning which an Occidental is most in the dark. Nevertheless, to me his work is not only highly suggestive, but also a mine of historic interest. To put it aside is to lose the historical perspective of the course of Buddhist philosophy."[1]

Here however we are concerned with the works of Buddhaghosa as indicating the development of his own mind rather than giving the expositions of earlier thoughts.

Chapter I.

Origin and Development of Buddhaghosa's Commentaries.

Before we discuss the question of the origin and development of Buddhaghosa's commentaries a word or two about the nature of a commentary seems necessary. A commentary means reading new meanings back into old texts according to one's own education and outlook. Its motive is to explain the words and judgments of others as accurately and faithfully as possible. This remark applies equally to all commentaries, Sanskrit and Pāli alike.

The teacher Revata is represented as saying to his pupil Buddhaghosa, "The Pali or Tripiṭaka only has been brought over here, no commentary is extant in this place. The divergent opinions of teachers other than the Theravādins do not likewise exist. The Ceylon-commentary, which is free from faults, and which was written in Singhalese by thoughtful Mahinda after due consultation of the method of expositions, taught by the supreme Buddha, put up before the three councils, and rehearsed by Sāriputta and others, is current among the people of Ceylon. Please go there and study it, and then translate it into Māgadhi which will be useful to the whole world."[1]

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[1] Introductory Essay, Buddhist Psychological Ethics, p. xxv.

From this it is evident that the commentaries were not to be found in India at the time of Buddhaghosa; they were all to be found in Ceylon. It follows further that the commentaries, as they come down to us, were not the original compositions of either Boddhaghosa or his illustrious predecessor Mahinda. These commentaries, as it appears from tradition, were originally the productions not of a single author but of a community of brethren. Mahinda was merely a translator in Singhalese and Buddhaghosa a retranslator in Pāli.

Buddhaghosa himself freely admits in his prologues to several commentaries,[2] that he annotated those passages only which were not commented upon by his predecessors, and the rest he only translated. All the available evidences point to the fact that within the first decade of Buddha's enlightenment Buddhist headquarters were established adjoining many important towns and cities of the time, viz. Benares, Rājagaha, Vesāli, Nālandā, Pāvā, Ujjenî, Campā, Madhurā, Ulumpā, and so on. At each of these places sprang up a community of Bhikkus under the leadership and guidance of a famous disciple of Buddha such as Mahākassapa, Mahākaccāyana, Mahākoṭṭhita, Sāriputta, Moggallāna, and the like. Following the rule of the wanderers or sophists they used to spend the rainy season at a royal pleasure garden or a monastery, after which they generally met together once a year at Rājagaha, Beḷuvana, Sāvatthi or elsewhere. Friendly interviews among themselves, and occasional calls on contemporary sophists, were not unknown. Among these various leaders of Bhikkhus, some were ranked foremost in doctrine, some in discipline, some in ascetic practices, some in story telling, some in analytical expositions, some in preaching, some in philosophy, some in poetry, and so on.[3] Among Buddha's disciples and followers there were men who came of Brahmin families, and who had mastered the Vedas and the whole of Vedic literature. It may be naturally asked: What were these profoundly learned and thoughtful Bhikkhus doing all the time ?

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[1] Mahāvaṁsa, Chap. 7; Anderson's Pāli Reader, p. 28. Visuddhimagga, ed. Buddhadatta, p. 2, cf. Sāsanavamsa, p. 31; it explains bhinnarūpā na vijjare as bhinnohutvā atthi, which is a misinterpretation.

[2] Sumaṅgalavilāsinî I, p. 1 (P.T.S). Sāratthapakāsinî, p. 1.

[3] *Vide* Etadaggavaggo, Aṅguttara Nikāya I; Mahāvaṁsa, edited by Geiger. '*The Council of Mahākassapa.*'

The Buddhist and Jaina texts tell us that the itinerant teachers of the time wandered about in the country, engaging themselves wherever they stopped in serious discussions on matters relating to religion, philosophy, ethics, morals and polity.[1] Discussions about the interpretation of the abstruse utterances of the great teachers were frequent and the *raison dêtre* of the development of Buddhist literature, particularly of the commentaries, is to be traced in these discussions. There are numerous interesting passages in the Tripiṭaka, telling us how from time to time contemporary events suggested manifold topics of discussion among the Bhikkhus, or how their peace was disturbed by grave doubts calling forth explanations either from Buddha himself or from his disciples. Whenever some interested sophists spoke vehemently 'in many ways in dispraise of the Buddha, the Doctrine and the Order,'[2] whenever another such sophist misinterpreted Buddha's opinion,[3] whenever a furious discussion broke out in any contemporary Brotherhood,[4] or whenever a Bhikkhu behaved himself improperly, the Bhikkhus generally assembled in the pavilion to discuss the subject, or were exhorted by Buddha or by his disciples to safeguard their interests. It was on one such occasion that Buddha was led to offer a historical exposition of the moral precepts in accordance with his famous doctrine. "One should avoid all that is evil, and perform all that is good,"[5] that is to say, an explanation of the precepts in their negative and positive aspects. This is now incorporated in the first thirteen suttas of the Dîgha-Nikāya, and is familiarly known as the Sîlakkhanda,—"The tract on morality,"—lending its name to the first volume of the Dîgha.[6] On another occasion Potaliputta, the wanderer, called on Samiddhi, and informed him thus: "According to Samaṇa Gotama, as I actually heard him saying, *Kamma* either by way of deed or by way of word is no *Kamma* at all, the real *Kamma* being by way of thought or volition only. For there is an attainment after having reached which one feels nothing (i.e. which transcends all sensible experience and pleasure and pain)."

"Speak not friend Potaliputta thus, speak not of him in this manner. Please do not misrepresent our teacher's point of view, for that is not good. He would never have said so."

"But tell me, friend Samiddhi, what a man will experience as the consequence of his deliberate action by way of thought, word and deed." "Pain," was the reply.[1]

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[1] *Vide* my paper "A short account of the Wandering Teachers at the time of the Buddha." (J.A.S.B. New series, Vol XIV, 1918, No. 7.)

[2] Dīgha-Nikāya, I, p. 2.

[3] Majjhima-Nikāya, III, pp. 207-8.

[4] Ibid., Sāmagāmasutta, II, pp. 243-4.

[5] "Sabba pāpassa akaranaṁ, Kusalassa upasampadā."

[6] "The Dialogues of the Buddha." II, pp. 3-26.

When a report of this discussion was submitted to Buddha he regretted that the muddleheaded Samiddhi had given such one-sided answer to the second point of the wanderer, whom he had never met in his life. For the right and complete answer would in that case have been, that 'he will experience either pleasure or pain or neither pleasure nor pain.' But as regards Samiddhi's reply to the first point, he had nothing to say against it.

Be that as it may, the fact remains that the wisdom and folly of Samiddhi, yet a young learner, formed the argument of Buddha's longer analytical exposition of the all-important subject of *Kamma*, which he termed the *Mahākammavibhaṅga*[2] in contradistinction to his shorter exposition, the *Cūlakammavibhaṅga*,[3] which was addressed to a young Brahmin scholar named Subha. Thus it can be established that the *Mahākammavibhaṅga* was the Sutta basis of the Abhidhamma Exposition of the *Sikkhāpadavibhaṅga* which is incorporated in the second book of the Abhidhamma Piṭaka.[4] But as a matter of fact, both these expositions have left their stamp on subsequent exegetical literature as is evidenced by the Nettipakaraṇa and the Atthasālinî[5] and other such works. Scanning the matter closely we can say that Buddhaghosa's exposition of kamma in his Atthasālinî is really the meeting-place of both.[6]

The Majjhima Nikāya contains many other illuminating expositions of Buddha, notably the Saḷāyatana Vibhaṅga,[7] the Araṇavibhaṅga,[8] the Dhātu Vibhaṅga[9] and the Dakkhinā Vibhaṅga,[10] which have found their due places in the Abhidhamma literature,[11] supplemented by higher expositions. They also have found their way into the later commentaries including, of course, the monumental works of Thera Buddhaghosa. Then we have from Thera Sāriputta, the chief disciple of Buddha, a body of expositions of the four Aryan truths, the Saccavibhaṅga[12] or Saccaniddesa,[13] which has found its due place in the second book of the Abhidamma Piṭaka, where it has been supplemented by a higher exposition (Abhidhamma bhājaniya) based upon the sutta exposition.[1] Sāriputta's exposition contains many of the stock-passages, or the older disconnected materials with which the whole of the Piṭaka literature, as we may reasonably suppose, was built up. This piece of independent commentary has been tacked on to the Satipaṭṭhāna Sutta, itself a commentary, and furnishes a datum of distinction between the Satipaṭṭhāna sutta in the Majjhima nikāya and the Mahāsatipaṭṭhāna sutta in the Dîgha-Nikāya.

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[1] The rendering is not literal, though substantially faithful.
[2] Majjhima Nikāya, III, pp. 207–215.
[3] Ibid., III, pp. 202–206. Nettipakaraṇa, pp. 182-183.
[4] Vibhaṅga, pp. 285–291.
[5] Atthasālinî, pp. 64–68.
[6] Majjhima Nikāya, pp. 215–222.
[7] Ibid., pp. 230–237.
[8] Ibid., pp. 237–247.
[9] Ibid., pp. 70–73.
[10] Vibhaṅga, pp. 70–73; pp. 82–90. Cf. Dhātukathā, etc.
[11] Majjhima Nikāya, III, pp. 248–252.
[12] Mahāsatipaṭṭhāna Suttanta Dîghanikāya.
[13] Vibhaṅga, pp. 99–112.

A complete catechism of important terms and passages of exegetical nature is ascribed to Sāriputta and is familiarly known as the Mahā Sangîti Suttanta,[2] of which a Buddhist Sanskrit version exists in Tibetan and Chinese translations under the name of Sangîti Parayāya Sūtra. The method of grouping various topics under numerical heads and of explaining by means of simple enumeration, invariably followed by Thera Sāriputta in the singularly interesting catechism above referred to, characterises two of the older collections, the Saṁyutta and the Aṅguttara and certain books of the Abhidhamma Piṭaka, notably the Puggala Paññatti, the materials of which were mostly drawn from the Aṅguttara nikāya. This is a fact which alone can bring home to us the nature of Sāriputta's work in connection with the Piṭaka literature. But Sāriputta does not exhaust the list. We have to consider other renowned and profoundly learned disciples of Buddha, among whom some were women, who in their own way helped forward the process of development of the commentaries. Take for example the case of Thera Mahākaccāyana, who was allowed to enjoy the reputation of one who could give a detailed exposition of what was said by Buddha in brief.[3] The Majjhima Nikāya alone furnishes four exegetical fragments[4] written by Mahākaccāyana, which are of great value as forming the historical basis of the three later works,[5] two in Pāli and one in Buddhist Sanskrit, which are all ascribed to him. The few fragments by Mahākaccāno (Mahākaccāyano) which have reached us are important for another reason, as exhibiting the working of the human mind in different directions. It is interesting to note that Mahākaccāno, so far as we can judge from these older fragments, seldom indulges in mechanical enumeration and coining of technical terms as Sāriputta did.

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[1] Vibhaṅga, pp. 193–205.

[2] Dîgha Nikāya, III. See for references Prof. Tākākusu's highly instructive article on the Sarvāstivādins in J.P.T.S., 1905, p. 67.

[3] Pahoti C' āyasmā Mahākaccānoimassa Bhagavatā saṁkittena uddesassa udditthassa vitthārena atthaṁ avibhattassa vitthārena atthaṁ vibhajituṁ Vibhajjanamhi Kaccāno, Dîpavaṁsa ed, by Oldenberg, p. 109, C.P. Etadaggavagga, Aṅguttara Nikāya.

[4] Majjhima Nikāya, I, pp. 110 F.; III, pp. 78, 194, 223.

[5] Viz. Nettipakaraṇa, Peṭakopadesa, Jñānaprasthāna Śāstra.

He, on the contrary, confined himself to bringing out the inner significance and true philosophical bearing of Buddha's first principles.

Then we have to make our acquaintance with Thera Mahākoṭṭhitha, who was an authority next to none but Buddha himself on Paṭisambhidâ or methodology of Buddha's analytical system. He gives us the characteristic marks or specific differences of current abstract terms signifying the various elements of experience.[1] He warns us at the same time against a possible misconception. Reason, understanding, perception, sensation and so forth are not entities. They are not dissociated, but all are inseparably associated[2] in reality. The first part of Mahākoṭṭhitha's explanation may be said to be the historical foundation of the Lakkhanahāra in the Nettipakaraṇa, of some passages in the Milinda-Pañho[3] in the commentaries[4] of Buddhaghosa; we have similiar contributions from Maggallāna, Ānanda, Dhammadinnā and Khemā, but we need not multiply instances.

A careful examination of the contents of the second book of the Abhidhammapiṭaka has proved beyond doubt that there is no hard and fast line between the Sutta and the Abhidhamma Piṭakas, the division resting mainly upon a difference of *modus operandi*. The Abhidhamma method was based upon, and followed closely in the line of, the Sutta exposition, which is evidently earlier. It goes without saying that the difference between the two methods is not only one of degree, but at times, one of kind. In spite of the fact that the Abhidhamma exposition is direct, definite and methodical, we cannot say that in all cases its value is greater than the Sutta exposition. There will always be a difference of opinion among Buddhist scholars as to whether the Abhidhamma books contain the genuine words of Buddha Gotama.[5] It is nevertheless certain that the major part of that literature is based upon the teachings and expositions of the great teacher. There may be a Sāriputta or some other unseen hands at work behind the scene, but on the whole, the credit, as history proves it, belongs ultimately to Buddha himself. The whole of the Abhidhamma Piṭaka has been separately classed by Buddhaghosa as Veyyākáraṇa or Exposition. We are told that this class comprises also the *gāthā*less or prose suttas which are not found in the remaining eight classes of early Buddhist literature.[6] The foregoing discussion has shown that the Vedallas need not be grouped as a separate class. There is no reason why the Cûlavedalla and the Mahāvedalla suttas in the Majjhima Nikāya should not be included in the veyyākaraṇa class. At all events it has been clearly proved that in the Tripiṭakas, excluding the Kathāvatthu, which was composed in the 3rd century B.C., we have two layers, so to speak, of Veyyākaraṇa, viz. the Suttabhājanîya and the Abhidhamma bhājanîya. Khandha, Vibhaṅga, Niddesa—these are but different synonyms of the same term. That is to say, the suttas containing terminology, definition, enumeration or explanation, whether with or without such names as Khandha, Vibhaṅga, Niddesa, constitute the first great landmark ; and the six Abhidhamma books, largely based upon the suttas, the second landmark in the history of the Buddhist commentaries. The third landmark is not so easy to determine as the first or the second. Here we have a choice between a few works [1] ascribed to Mahākaccāno and the Kathāvatthu of which Thera Moggaliputta Tissa is said to be the author. As regards the date of the latter, it is pretty certain that the book was composed about the time of the third Buddhist council held under the auspices of King Asoka. The case of Mahākaccāno's works is somewhat different. A careful survey of the Peṭakopadesa which is still buried in manuscripts shows that whatever its date of composition, it is a supplementary treatise to the Nettipakaraṇa of which a beautiful edition in Roman character is given to us by Prof. E. Hardy. A Buddhist Sanskrit work, the Jñānaprasthāna Śāstra, by a Mahākātyāyana, is held, as Prof. Tākākusu informs us, as an authoritative text by the Sarvāstivādins. This Śāstra is mentioned by Vasuvandhu in his Abhidharmakoṣa [2] as one of the seven Abhidhamma books. The work was translated into Chinese by Saṅghadeva and another in A.D. 383. Another translation was made in A.D. 657 by Hiuen Tsang, who translated also the Abhidharmamahāvibhāsaśāstra, a commentary on Mahākātyāyana's work composed during the council under Kaniṣka.[3] The Chinese traveller tells us that the Jñānaprasthāna śāstra was composed 300 years after the death of Buddha. Buddhist scholars have yet to settle the question whether or not Jñānaprasthāna has anything in common with the Nettipakaraṇa or with Paṭṭhāna, the seventh book of the Abhidhammapiṭaka. The Netti, as we now have it, contains a section named Śāsanapaṭṭhāna which embodies a classification of the Piṭaka passages according to their leading thoughts.

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[1] Pajānāti pajānātîti . . . . . . tasmā paññavā ti vuccati . . .
Vijānāti vijānâtîti . . . . . . tasmā viññananti vuccati . . .
Majjhima Nikāya, I, p. 292.

[2] Ibid.—Ime dhammā saṁsaṭṭhā no visamsaṭṭhā . . . . .

[3] Milinda Pañho, p. 62. (Edited by Trenckner).

[4] e.g. Sumangala-vilāsinî, I, pp. 62–65.

[5] See for a learned discussion on the subject among the Theras, Atthasālinî, pp. 29–31.

[6] Sumaṅgala-vilāsiṇî I, p. 324; Atthasālinî, pp. 25–26.

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[1] Hardy. Introduction to the Nettipakaraṇa, p. 33, F. I. Kaccāyanapakaraṇaṁ, Mohanenittipakaraṇaṁ, Nettipakaraṇaṁ, Cuttanenitti, petakodesa, and Vannaniti.

[2] E. Burnouf's Introduction, p. 447.

[3] Beal's Buddhist Records, I, pp. 174–175. Cf. Bunyunanjio's Catalogue, Sub. No. 263.

Judging from the valuable extract from the Jñānaprasthāna given by Prof. Tākākusu we can decide once for all that the work is not identical with the Pāli Abhidhamma book Paṭṭhāna, though presumably it bears some relation to the latter. The Netti and Jñānaprasthāna have many points in common, as they were written to serve a similar purpose.

In the opening paragraphs or pages of his two books, Mahākaccāyana frankly states that his work was not to start a new idea but to produce a systematic analytical exposition of the expressions of others (paratoghosā).[1] The parikkhārahāra [2] of the Netti is a chapter based upon the paṭṭhāna, though it throws new light on the subject of causal correlation. As appears from the section on Nayasamuṭṭhāna, Mahākaccāyana refers to the Buddhist schismatic or heretics (Diṭṭhicaritā asmiṁ sāsane pabbajitā), whom he sharply distinguished from the outsiders (Diṭṭhicaritā ito bahiddhāpabbajitā). Such a thing as this is not possible within the first century of Buddha's Nibbāṇa. It presupposes the four nikāyas and all other older books of the three piṭakas from which it has quoted several passages. Without going into further details, we will not be far from the truth to suppose that the works of Mahākaccāyana were indeed a connecting link between the Tripiṭaka on one side and all subsequent Buddhist texts on the other. Thus if we have to choose between his works and the Kathāvatthu, the priority must be said to belong to the former.

The Kathāvatthu, which is a Buddhist book of debate on matters of theology and philosophy represents the fourth landmark. Buddhaghosa's[3] plea for affiliation of this significant text to the Pali canon is ingenious enough. Buddha laid down the main propositions (Mātikā) which were discussed later by the adherents of different schools of thought.[4] It may however be doubted whether a book of controversy such as the Kathāvatthu can be regarded as a landmark in the history of the commentaries. But a closer investigation will make it evident that this book of controversy is looked upon in one way as no more than a book of interpretation, as Mahākaccāyana[5] rightly points out that the Buddhist heretics, in spite of their individual differences, agreed in so far as their regard for the teachings of the master was concerned. The few specimens of controversy which the Kathāvatthu has embodied exhibit that both sides referred to Buddha as a final court of appeal. All have quoted passages from the canon, though their interpretations differ widely. Next we have to think of the "Questions of King Milinda" (Milinda-Pañho), which is a romantic dialogue between king Menander and Thera Nāgasena. It presupposes the Kathāvatthu and may be regarded philosophically as a richer synthesis of isolated movements of Buddhist thought than the former.[1]

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[1] B. M. Barua's Prolegomena to a history of Buddhist Philosophy, pp 10, 42.

[2] Nettipakaraṇa, pp. 78–80.

[3] Ibid., pp. 110–112.

[4] Atthasālinî, pp. 4–6.

[5] Nettipakaraṇa, p. 112.

The time when the Milinda Pañho was composed and when Buddhaghosa was writing out his own works, quoting various Sinhalese commentaries,[2] can be pointed out as the sixth landmark. Besides these Ceylon commentaries Buddhaghosa has made casual reference to the opinions of the Dîghabhānakas,[3] the Majjhima Bhānakas[4] and other such schools of Theras. In his introduction to the Sumaṅgalavilāsinî[5] he gives us a short account of these schools of Theras which were originally but so many schools of recitation rather than of opinion. In the background of Buddhaghosa's works which are catalogued here as the seventh landmark, there are the whole of Tripiṭaka, the works of Mahākaccāyana, the Kathāvatthu, the Milinda-pañho,[6] the Pannattivāda of teachers other than the Theravadins,[7] certain Vitaṇḍāvādins, Pakaṭivāda[8] (the Sankhya or the yoga system), and the views of Bhikkhus[9] of Ceylon. To sum up: we have seen that there is evidence enough to confirm the truth of the tradition that neither Buddhaghosa, nor Thera Mahinda, nor the Theras of old, were the originators of the commentaries; but we cannot agree with them when they all deny their claim to originality. The Niddesa which is an old commentary on certain suttas in the Sutta Nipāta cannot compare favourably with Buddhaghosa's Paramatthajotikâ. The Peṭakopadesa[10] of Mahākaccāyana, of which a passage is quoted by Buddhaghosa, is not the Atthasālinî. In justice to all, we can say that Buddha himself, his disciples and their disciples were those who prepared the way for great Buddhaghosa, the commentator.

CHAPTER II.

Enquiries into Buddhaghosa's Commentaries.

A critical survey of Buddhaghosa's works suggests to an inquiring mind many far-reaching questions of which very few have indeed been hitherto examined or answered. Perhaps the most important of them is this :—How far has Buddhaghosa revealed himself in his commentaries headed by the Visuddhimagga ? In other words, what historical data of Buddhaghosa's life can be culled from his works ? Other questions that may arise are all subsidiary to this. We may ask, for example, (1) Supposing, as the Mahāvaṁsa would have us believe, that Buddhaghosa was born in a Brahmin family of Gayā, mastered the Vedic literature with all its auxiliary sciences and arts and learnt the views of Patañjali so well that he could cite them verbatim, it is to be inquired :—Can we find any trace of the influence of Brahmanic culture and of the system of Patañjali on his works ? (2) Where did he meet Thera Revata, who converted him to the Buddhist faith after defeating him by arguments in a philosophical discussion ? (3) Can we adduce any substantial proof in support of the tradition that he wrote his Atthasālinî while in India ? (4) What reminiscences of Ceylon are to be found in his commentaries ? (5) What light is thrown by his works on the social, political, philosophical, literary, and artistic history of India of his time ? (6) What is the relation of Buddhaghosa to Buddhadatta and other teachers of South India in regard to the interpretation of Buddhist philosophy ? (7) What are his special contributions to Buddhist or to Indian philosophy ? (8) In what way was Buddhaghosa a connecting link between Northern India, the Deccan and Ceylon ? (9) Can we discover in Buddhaghosa any anticipation of Śaṅkara ? (10) What is the place of Buddhaghosa as a writer and philosopher in the history of India, particularly in the history of Buddhism ? (11) How is it that Buddhaghosa makes no reference to Mahāyāna Buddhism ? (12) What is the immediate background of Buddhaghosa's philosophy ? (13) What is the indebtedness of Buddhaghosa to the Buddhist kings and teachers of Ceylon ? As each of these questions requires a separate paper, we shall content ourselves in the following pages with attempting to answer only one with the help of the records well within our reach.

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[1] Kathāvatthu Commentary by Buddhaghosa; Vasumitra's work on the 18 schools, the Samanadha Paracancakra by Bhavya, etc.

[2] Vide "Buddhist Manual of Psychological Ethics," pp. xxiii–xxiv.

[3] & [4] Atthasālinî, pp. 151, 399, 407, 420.

[5] Sumaṅgala-vilāsinî, pp. 11–15.

[6] Atthasālinî, pp. 112, 114, 119, 120, 122, 142.

[7] Puggala Paññatti Commentary, P.T.S., pp. 173–175.

[8] Atthasālinî (Ceylon Edition), pp. 3, 90, 92, 241.

[9] Puggala Paññatti Commentary (Ceylon Edition), p. 172.
"Titthiyānaṁ anupakatipurisādikassa vā" (Visuddhimagga, p. 407).
"Kiṁpakativādinaṁ pakativiya avijjā pi akoranaṁ mulakoranaṁ lokassāti," p. 406.

[10] Atthasālinî, p. 165; Petake Vuttaṁ.

CHAPTER III.

Buddhaghosa in his Commentaries.

Buddhaghosa has left for us no other record of his life than his commentaries. The information that comes from other sources is meagre. Mr. Gray was the first to collect in his Buddhaghosupatti some references to his life from the Mahāvaṁsa, the Sāsanavaṁsa, and the like. The accounts given in these works are hardly anything but anecdotes which may be summed up as follows.

Buddhaghosa was born in a Brahmin family in the vicinity of the Bodhi terrace. He was brought up during his early years in Brahmanic tradition. He mastered the three Vedas together with all the supplementary works on sciences and arts. He was an adherent of the system of Patañjali previous to his adoption of the Buddhist faith. Following the usage of his time he wandered about the country as a sophist. He called at a monastery where he happened to meet a Thera Revata, who is said to have defeated him in a philosophical discussion. He studied the Pāli Tripiṭaka under Revata. He wrote a philosophical treatise entitled the Ñānodaya. He also wrote a commentary on a certain section of the Dhammasanganî under the name of the Atthasālinî. He was engaged in writing a Parittaatthakathā when Thera Revata urged him to go to Ceylon. The Sāsanavaṁsa tells us that he accidentally met on the way Thera Buddhadatta who was then returning from Ceylon.[1]

Buddhaghosa visited Ceylon during the reign of king Mahānāma; the sole object of his journey to Ceylon was to retranslate the Singhalese commentaries into Māgadhi. He studied the Singhalese commentaries under Thera Sanghapāla of Mahāvihāra at Anurādhapura. There he produced the Visuddhimagga which is esteemed as an Encyclopædia of Buddhism. After that he spent his time at the Ganthakāra Monastery, where he composed all his commentaries; thereafter he returned to India. It is recorded in the Sāsanavaṁsa that Buddhaghosa was a native of Ghosagāma near the Bodhi terrace. The Brahmin Kesi was his father and Kesiyā his mother. The primary object of his voyage to Ceylon was to retranslate the Tripiṭaka into Pāli. The Mahāvaṁsa is silent on these details.

Buddhaghosa is reticent about himself. He nowhere tells us who he was or where he was born. There are occasional references to Ceylon and to his teachers and friends, from which nothing definite can be inferred regarding his own life. That the Visuddhimagga was his first production in Ceylon is beyond dispute. In the preface to his Samantapasādikā, the commentary on the Vinaya Piṭaka, he tells us that this was the first commentary he wrote on the canonical texts. He gives an apology for undertaking to write a commentary on the Vinaya Piṭaka first in reversal of the usual order of Dhamma and Vinaya. He says that Vinaya is the foundation of the Buddhist faith. The Samantapasādikā was followed by his commentaries on the four Nikāyas in succession, which preceded his commentaries on the seven books of the Abhidhamma Piṭaka. The Jātaka commentary was evidently composed before the Paramattojyotikā,[2] being a serial commentary on certain books of the Khuddakanikāya. His later commentaries refer to his earlier ones [1] and all presuppose his Visuddhimagga.[2] Hence a concordance of them may be an invaluable aid to the study of Buddhaghosa and his works.

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[1] Sāsanavamsa, page 29.

[2] Paramatthajotikā, II. Ed. Helmer Smith, Vol. I, page 21. "Esa jātakatthakathāyam vutta idha na vittharita."

Buddhaghosa was an inhabitant of south Behar. This part of the tradition may be taken for granted. His connection with a Brahmin family and with Brahmanic tradition is undeniable. The evidence of his commentaries amply testifies to the fact. His comment upon the Pāli passage [3] relative to the supplementary treatises of the Vedas could not be expected from one who was not conversant with the whole of the vedic literature. His emphasis on Vinaya is another proof of the influence of his previous learning. His definitions of killing, theft etc. shows an enormous improvement on older expositions. Buddha as a psychologist was quite content with the definition of Kamma as volition (Cetanā Bhikkave vadāmi Kammaṁ). Buddhaghosa framed a definition accordingly.[4] But, as appears from his explanation, for him an action is no action until the will is actually manifested in conduct,[5] which goes to prove that his point of view was juristic or practical.

The tradition telling us that he was an adherent of the system of Patañjali also seems to have historical accuracy. He is insolent throughout his works in his attacks on Pakativāda, i.e. the Sāṅkhya or the Yoga system. He shows extravagant zeal for differentiating the Buddhist conception of Avijjā from the Pakativādin's conception of Pakati as the root cause of things,[6] and the Buddhist conception of Nāmarûpa from the outsider's conception of Purisa and Pakati. He betrays nevertheless his previous relation with the Sāṅkhya and the Yoga systems. His conception of Nāmarûpa is veritably like the Sāṅkhya conception of Purusa and Prakriti. Even the very simile of the blind and the lame by which the two conceptions are illustrated is the same.[1] It might be argued that Buddhaghosa based his conception on the authority of the earlier Buddhist thinkers, notably Nāgasena and Aśvaghosa.[2] But who can deny that the Buddhist thinkers, too, were greatly influenced by the Sāṅkhya line of thinking? Indeed taking into consideration all the available evidence, we cannot but agree with M. Oltramare in maintaining that the Buddhist conception of Nāmarûpa was from a certain date steadily tending towards the Sāṅkhya conceptions of the Purusa and Prakriti. It would be going too far away from our immediate object to institute an enquiry into the relationship between the Buddhist philosophy and mode of self-realization on one hand and the Yoga system on the other. Accepting as a working hypothesis that the relationship is in many respects very close, we need not stretch our imagination to realize how Buddhaghosa easily passed from the old to the new. The fact of Buddhaghosa being thus a connecting link between the two systems is enough to accord to him a very important place in the history of Indian Philosophy. Buddhaghosa enriched his Buddhist heritage with fresh materials from other systems; consider, for example, his use of the term "Samūha," which reminds us at once of Patañjali's Mahābhāṣya.[1] There are many other similar passages.[2] The student of Buddhaghosa can judge for himself the great scholar's tender regard for his friends in Ceylon, his devotion to his teachers, his gratitude to his patrons, his meekness of spirit, his resourcefulness, his vast erudition and other traits which characterize a great teacher of mankind. Although it is not definitely known at what age he died, it is conceivable that he lived long enough to see his labours amply rewarded, enjoy the world-wide fame that he so well deserved. He did not live in vain. As long as Buddhism remains a living faith among mankind Buddhaghosa will not cease to be remembered with reverence and gratitude by Buddhist peoples and schools. We shall touch on just one more point before we conclude. Buddhaghosa is perhaps the greatest of celebrities of the Mahāvihāra at Anurādhapura, but it remains yet to determine his place in the history of the relation of

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[1] Sumaṅgala-vilāsinî, I, p. 70. "Atthakehi samantapāsādikain Vinayatthakathaṁ gahetabbaṁ." Puggala-Paññatti commentary, p. 222. "Ayaṁ Aṅguttaratthakathāyaṁ nayo." See also p. 247; Atthasālinî refers to the Samanta-Pāsādikā, pp. 97, 98, also p. 71 to the Vibhaṅga Commentary, p. 407.

[2] Atthasālinî, pp. 168, 183, 186, 187, 190, 198. Sumangala-vilāsinî, I, p. 2. Puggala-Paññatti, p. 254 etc.

[3] Sumaṅgala-vilāsinî, I, pp. 247-248. "Mahāpurisa-lakkhanan ti mahāpurisānaṁ Buddhādînam lakkhaṇa-dîpakam dvādasasahassagandhappamāṇaṁ sattham."

[4] Ibid., pp. 69-80, Atthasālinî, pp. 85-182. Paramatthajotikā, I. pp, 23-37. "pānopāna-saññino jivit-indriyupacchedaka-upakkama-samutthāpikā kāyavacî-dvārānaṁ aññatarappavatta vadhaka-cetanā pāṇātipāto."

[5] e.g Sumaṅgala-vilāsinî-"Tassa panca sambhārā honṭi: "pānopāna-sannitā Vadhaka-uttam-upakkama-tena maranaṁ ti."

[6] Visuddhimagga. Ceylon edition, pp. 407-8. Atthasālinî (P.T.S.), p. 180. Prolegomena. op. cit., p. 43.

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[1] Cf. The passage quoted in Vyāsa's commentary on Yoga Sūtra III, 44. "Sāmānya viseshasamudaotra dravyam samuhaḥ pratyastamita bhedâvayavanugataḥ śarîraṁ vriksho Yuthaṁ vanamiti . . . . Ayutasiddhâvayava bhedannataḥ samūha dravyam iti patanjaliḥ." Atthasālinî, p. 61.

"Samūhasankhato pana samayo
anekesam sahuppattim dîpeti."

Cf. p. 305 or Sangahasaddo, p. i. Cf. Ibid., p. 167, "paṭhavî kāyo paṭhavî samūha va"

[2] Paramatthajotikā II, Vol. I, p. 169. "Athavā sante na kurute iti sante na sevati ti attho yathā rājānāṁ sevati ti etasmim atthe rājānaṁ rājānaṁ pakurute ti saddavidu mantenti." It is an application of the rule of Pānini I-3-32. "gandhanavakshapana sevana sahasikyā pratiyatna prakathanapayo gashu krinaḥ." Cp. Bhattikāvya, VIII, 18.

Northern India with the Deccan. In the epilogue of his commentary on the Vinaya Piṭaka he tells us that he completed his great work in the 21st year of the reign of king Sirinivāsa of Ceylon who was his benevolent royal patron.[1] Perhaps he refers to the same king under the name of Sirikudda in the epilogue to his commentary on the Dhammapada.[2] It is left to further research to settle whether or not Sirinivāsa was another name of king Mahānāma,[3] during whose reign he visited Ceylon according to the Mahāvaṁsa. The Revd Bhikkhu H. P. Buddhadatta is of this opinion. He points out that nowhere else is mentioned a king of Ceylon by the name of Srinivāsa or Sirikudda.

Buddhaghosa refers to king Duṭṭhagāmaṇî Abhaya,[4] the national hero of Ceylon, and to king Coranāga,[5] son of king Vaṭṭagāmaṇî. He also makes mention of a king Mahānāga whose munificent gifts in connection with the art of healing at Penambarigana had won for him a lasting fame;[6] king Mahānāga is perhaps no other than king Buddhadāsa, father of king Mahānāma mentioned in the Mahāvaṁsa (Chap. XXX. 171).

Thera Buddhadatta, another celebrity of the Mahāvihāra of Ceylon, was probably an elder contemporary of Buddhaghosa. He was an inhabitant of Cola kingdom, situated below the Kāverî. He tells us that his royal patron was king Accutavikkanta of the Kaḷamba dynasty. All his works were written at the famous monastery erected by Veṇhudāsa or Kaṇhadāsa on the bank of the Kāverî.[7]

It is doubtful if the two teachers met each other either in India or elsewhere. They drew materials from the same source no doubt. This fact can well explain why the Visuddhimagga and the Abhidhammavatāra have so many points in common. In point of fact the two teachers wrote independently of each other. Nevertheless, whether prior or posterior, the Abhidhammāvatāra of Buddhadatta can be safely regarded as a catechism of the last portion of the Visuddhimagga. Buddhadatta, too, used the simile of the purblind and the lame as an analogy of the relation between nāma and rūpa.[8] Buddhadatta's division of term into samūha and asamûha is another interesting point.[9] It will be remembered that such a division of terms as this was far in advance of older classifications embodied in the Puggala Paññatti commentary.[1] Supposing that Kumāra Gupta of the Imperial Gupta dynasty was a contemporary of king Mahānāma of Ceylon and that Buddhaghosa was a younger contemporary of Thera Buddhadatta, it follows that king Accutavikkanta of Kaḷamba Dynasty was a contemporary of Kumāra Gupta.

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[1] Viññāpana, Visuddhimagga, A. p. 4. Buddhadatta, p. iv.
"Palāyantassa sukalam lankādîpam nirabbudam Ramo sirinivasassa samavisatime kheme jayasamvacehare ayan.
Āraddha ekavisamhi sampatte parinitthita ti."

[2] Ibid., p. iv. Dhammapada Commentary, P.T.S, p. i.

[3] Ibid., pp. 4, 5.

[4] Atthasālinî, p. 81.

[5] & [6] Ibid., p. 399.

[7] Abhidhammāvatāra, P.T.S., pp. 13, 14, 16 and 17.

[8] Abhidhammāvatāra, P.T.S., p. 115.

[9] Ibid., pp. 82-3.

It is conceivable that the Buddhist monastery where Buddhaghosa met Thera Revata was situated somewhere in South India, say, near the upper banks of the Godāvarī. Buddhaghosa's knowledge of South India below the Godāvarī is next to nothing. Only in one place he records that the Godāvarī was the border line between the territories of two Andhra Kings, that is to say, between Assaka and Alaka or Mulaka.[2] In the Chāndogya Upanishad we read that King Kekaya of Aśvaka was an elder contemporary of Uddālaka Āruṇî.[3] The Rāmāyaṇa points to Rājagṛiha as the capital of Aśvaka, which was undoubtedly a confusion on the part of Vālmîki. The Rāmāyaṇa also points to a matrimonial alliance between Kosala and Aśvaka. It is difficult to imagine the possibility of an intermarriage between an Aryan prince and an Āndhra princess. Thus it would be more true to fact to suppose that as far back as the eighth century B.C. Aśvaka was an Aryan kingdom. The Pārāyamvagga of the Suttanipāta speaks of a trade route or a sort of trunk road extending from Sāvatthi to as far south as Patiṭṭhāna.[4] In Buddhaghosa's time Asvaka and Mulaka were two Āndhra kingdoms.

The scene of Buddhaghosa's career as a scholar in India was confined between the Ganges on the north and the Godāvarî on the south. These two rivers were uppermost in his mind.[5] Elsewhere he defines southern Provinces (Dakṣinajanapada) in the Dekkhan (Dakkhināpatha) as a tract of land lying to the south of the Ganges.[6] His personal acquaintance with the Andhra countries is evident from his detailed account of an island in the midst of the Godāvarî.[7] In an interesting passage of the Sumaṅgala-Vilāsinî, he has described apparently a local aboriginal custom of bleaching human bones.[8] Moreover we cannot fail to find in him anticipations of the Māyāvāda of Śaṅkara. Matter summed up in terms of the four gross elements is unknowable. The impressions which we have of matter are mere appearances. If our hypothesis be true, it will be a most fruitful enquiry, in the immediate future, to determine how Thera Buddhaghosa was a connecting link between Northern India, the Dekkhan and Ceylon.

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[1] Cf. Puggala Paññatti Commentary, P.T.S., p. 173.

[2] Paramatthajotikā, II, Vol. II, p. 581.

[3] Chāndogya Upanishad V. II. 4.

[4] See Buddhist India, p. 103

[5] Atthasālinî, p. 140.

[6] Sumaṅgala-vilāsinî, I, p. 265.

[7] Paramatthajotikâ, II, Vol. 2, p. 581.

[8] Sumaṅgala-vilāsinî, I.P. "Dhopananti."

6. Influence of the five heretical teachers on Jainism and Buddhism.

By BIMALA CHARAN LAW, M.A., M.R.A.S.

In view of the scanty documents available it is still an open question as to whether an extensive research can be instituted with regard to the influence of the doctrines of the five heretical teachers on the development of Jainism and Buddhism. So far as I can recollect Prof. Max Muller was the first to attempt to assign a definite position to them in the history of the six systems of Indian philosophy. With all deference to that great scholar, I must say that he has hardly succeeded in establishing the precise relation in which these teachers stand either to the history of the six systems of Indian philosophy or to that of Jainism and Buddhism. A short account of the six heretical teachers (including Mahāvîra) appears in Rockhill's Life of the Buddha[1] drawn from the Tibetan translation of the Sāmaññaphala Sutta. Mr. Rockhill gives in his Appendix extracts from the Jaina Bhagavatî XV. on the intercourse between Mahāvîra (Nigaṇṭha Nāthaputta) and Gosāla Maṅkhaliputta, and also an account of the doctrines of the six heretical teachers according to two Chinese versions of the Sāmaññaphala Sutta. But he too does not endeavour to solve the real problem in hand. The same remark applies to Spence Hardy, Dr. Oldenberg, and other Buddhist writers who have been content with furnishing us with a mere legendary account of them. Prof. Jacobi in his Introduction to the Jaina Sutras, pt. II, p. xxvii F, is the first to call our attention to the great importance of these teachers. "The records of the Buddhists and Jainas about the philosophic ideas current at the time of the Buddha and the Mahāvîra, meagre though they be, are of the greatest importance to the historian of that epoch. For they show us the ground on which and the materials with which, the great religious reformers had to build their systems The considerable similarity between some of these heretical doctrines on the one side and Jaina or Buddhist ideas on the other, is very suggestive, and it favours the assumption that the Buddha as well as Mahāvîra owed some of their conceptions to these very heretics." Alluding to these significant words of Prof. Jacobi, Dr. Rhys Davids remarks, "the philosophical and religious speculations contained in them (that is, the Buddhist and Jaina records) may not have originality, or intrinsic value, either of the Vedanta or of Buddhism. But they are none the less historically important because they give evidence of a stage less cultured and more animistic, that is, earlier. And incidentally they will undoubtedly be found, as the portions accessible already show, to contain a large number of important references to the ancient geography, the political divisions, the social and economic conditions of India at a period hitherto very imperfectly understood." [1]

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[1] pp. 100-105.

Besides Prof. Jacobi we must also mention Mrs. Rhys Davids as a writer, who has made a very serious attempt to discuss the manner in which these teachers paved the way even by their sophistry for the great Buddha. The Buddhist records earlier as well as later abound in incidental references to a number of teachers mentioned promiscuously as the six Tithiyas or Tirthikas. Some of these records can hardly bear the scrutiny of critical research, inasmuch as they tell us in various ways that the fame of these teachers faded away before the rising glory and dazzling brilliance of Buddha's career. For instance, in the Jataka,[2] these teachers are contrasted with Buddha Gautama as a filthy crow in comparison with the painted, well-trained and sweet-voiced peacock.

Milinda Pañho, (The Question of the king Milinda), which can be dated the second century of the Christian era, contains a spurious account of the six Titthiyas which leads us back to the Sāmaññaphala Sutta that might be taken as the most typical of genuine Buddhist fragments. Meagre as the account in the Sutta is, and as there is a great possibility of misconceptions on the part of the Buddhist writers about their opponents' views, we must be careful not to come to a conclusion on the basis of the Sāmaññaphala Sutta alone. That is to say, its evidence must be accepted with due care and we must see that it tallies with other passages contained in the Canon. Of the six teachers, Jaina Angas unfortunately only mention Makkhali Gosālaputta and Nigaṇṭha Nāthaputta (identified with Mahāvîra). But there are striking passages here and there embodying the doctrines of the teachers though their names are not expressly mentioned.

In the Sāmaññaphala Sutta and other older Buddhist Suttas, the six teachers are spoken of in identical terms as "the head of an order, of a following, the teacher of a school, well-known and of repute as a sophist, revered by the people, a man of experience who has long been a recluse, old, and well-stricken in years." (The Dialogue of the Buddha, Vol II, p. 66).

The Mahāsakuladāyî Sutta of the Majjhima Nikāya[3] alludes to Magadha as seething with speculative fervour stirred up by these Titthiyas. The same Sutta points out that the disciples of these teachers carried on philosophical discussions with indomitable energy and boldness characterising the spirit of the age. In spite of the general tendency of the Jaina works to paint Gosāla in dark colours, the Bhagavatî had to admit that Gosāla attained Jinahood and that he was recognised as a teacher at Sāvatthi some two years before Mahāvîra. In the Sabhiya Sutta of the Suttanipāta,[1] a wandering teacher named Sabhiya asked Buddha if he was younger in age than the six distinguished teachers and junior to them by renunciation. Samaṇa Gotama simply evaded the question by telling the wanderer that seniority went by wisdom and not by age (S.N. edited by Faüsboll, pp. 91-92). But we have another important passage which definitely states the fact that the Samaṇa Gotama was a younger contemporary of these six teachers.

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[1] Buddhist India (Rhys Davids), pp. 163-164.
[2] Jātaka (Faüsboll), No. 339, Vol. III, pp. 126-128.
[3] p. 2, Vol. 11 (P. T. S).

The Sāmagāma Sutta of the Majjhima Nikāya[2] and the Pāṭika Sutta of the Dîgha Nikaya (Vol. III) bear evidence to the fact that Nigaṇṭha Nāthaputta or Mahāvîra predeceased Buddha by a few years. Dr. Hœrnle conjectures that Mahāvîra died some five years before the Buddha.[3] It follows from the evidence of the Abhayarājakumāra Sutta[4] of the Majjhima Nikāya that Mahāvîra was aware of the fact of dissension between Buddha and Devadatta. In the opinion of Prof. Kern, the death of Bimbisara took place when Buddha had reached the age of 72 years, and that *Buddhadatta's* agitations against the Buddha must be dated some time after this event.[5] Judging from this documentary evidence Dr. Hœrnle's conjectures would seem to have substantial historical accuracy. Mahāvîra is said to have lived seventy-two years and Buddha is said to have died at the age of eighty. Thus the greater part of Mahāvîra's life coincides with that of Buddha. After carefully examining the data supplied by the Jaina records, Dr. Hœrnle has come to the conclusion that Gosāla Maṅkhaliputta had become a far-famed teacher some two years before Mahāvîra and that the latter survived the former by sixteen years.[6]

Notwithstanding persistent insinuations as to Gosāla being formerly a disciple of Mahāvîra and as to his rupture with his teacher there is room for doubt if Gosāla had ever been a disciple of Mahāvîra. While the malicious Jaina accounts deepened the mystery about the relation between the two teachers, we can have recourse to the Buddhist writings for more reliable information. The Buddhist fragments are unanimous in referring to them as the most distinguished sophists of the time, the recognised founders of the two separate schools, namely the Ājivikas or Maskarins and the Nigaṇṭhas (Jainas).

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[1] p. 91 (P. T. S). [2] Vol. II (P. T. S), p. 243.

[3] Ājivikas (Hastings' Encyclopaedia of Religion and Ethics).

[4] Majjhima Nikāya, Vol. I, p. 392.

[5] Kern's Indian Buddhism, pp. 38-39.

[6] Upāsakadasāo, Tr., pp. 110-111.

To the important question as to the precise relationship between the two teachers we shall return later. At this stage of our enquiry we can safely assert that Maṅkhali Gosāla was one of the older contemporaries of Mahāvîra. As regards the remaining four sophists, it is not very easy to determine their dates. On the authority of the Buddhist Suttas we can say no more than that they were all amongst the older contemporaries of Buddha Gotama. There are, however, a few passages in the Buddhist Canon which furnish us with a clue to the date of Sanjaya of the Belaṭṭhiclan. The Buddhist Suttas make mention of Sanjaya Belaṭṭhiputta, and of a wanderer named Sanjaya. The former is counted among the six heretical teachers or Aññatitthiya Paribbājakas, that is, the sophists belonging to other schools, and the latter is alluded to as the previous teacher of Sāriputta and Maggallāna who became, later on, the chief disciples of Buddha Gotama. After closely examining the import of some Buddhist passages of the Aṅguttara Nikāya, it seems very probable that Sanjaya Belaṭṭhiputta was the same person as Sanjaya the wanderer. It is needless to add that Kern and Jacobi are of the same opinion on this point.[1] If so, it follows that Sanjaya died shortly after the time when Sāriputta and Maggallāna had joined (along with many disciples of Sanjaya, their former teacher) the Buddhist order in the second year of Buddha's career as a teacher, that is, in the 37th year of Buddha's life.[2] Of course, we have evidence to prove that though Sanjaya predeceased Buddha, a school survived at least up till the reign of King Asoka.

Thus we see that Sanjaya was an older contemporary not only of Buddha but also of Mahāvîra and Maṅkhali Gosāla.

A Kavandhin Kātyāyana is mentioned in the Prosnopanishat as a younger contemporary of Pippalāda to whom we owe the outline of the Sāṅkhya system of Philosophy.[3]

The nickname Kavandhin applied to the name of Kātyāyana is of some interest. Kavandhin or Kukuda was really a nickname intended to distinguish the famous sophist from other teachers bearing his name.

Supposing that Kukuda Kātyāyana or Kavandhin Kātyāyana was a younger contemporary of Pippallāda and that the Buddha was a younger contemporary of Kātyāyana, it does not seem improbable that Kātyāyana was of the same age as Sanjaya. Prof. Kern relates a legend telling that Puraṇa Kassapa committed suicide by throwing himself into the river with a large jar tied to his neck some time in the 42nd year of Buddha's life.[4] We have reason to believe that Ajitakesa Kambali was of the same age as Kukuda Kātyāyana. The series of dates here suggested must be regarded as provisional and tentative. It must be established by corroborative evidence of the inter-connection of the doctrines of these six renowned sophists. It is of little importance whether one teacher was born or dead a few years earlier or later than another. What is of real importance to the historian is the proof that these teachers in spite of their divergences belonged to the same period of thought-development in India and prepared the way for the doctrine of Buddha.

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[1] Kern's Indian Buddhism, p. 32.

[2] Kern's Indian Buddhism, p. 25.

[3] Prasnopanishat, Pras. I. 1.

[4] Kern's Indian Buddhism, p. 33.

It may be of some interest to note that the Buddhist attitude towards Mahāvîra and his doctrine was not so hostile as in the case of his predecessors. Buddhaghosa, the celebrated Buddhist commentator, goes so far as to suggest that Mahāvîra's doctrine of Cātuyāma Samvara (four-fold Restraints) has some good points in it. I am told by my friend Dr. B. M. Barua, M.A., D.Litt. (London), that Dr. F. W. Thomas is inclined to assign to Mahāvîra the same position in relation to the five earlier wandering teachers as Socrates stands in relation to the Greek sophists. Leaving aside for the moment the question as to whether Mahāvîra can be thus separated from his sophistic predecessors, it is important to observe that the Buddhists distinguish these six teachers in a body from other wandering teachers of the time, as the Aññatitthiya paribbājakas from the Brahmin Paribbājakas.[1]

The Buddhist word Pharusavācā can, of course, supply a criterion by which we can distinguish two classes of paribbājakas. It is in reference to the six schools of philosophy and to these alone that Buddha and his contemporaries said that they were in the habit of exchanging wrangling phrases in the heat of philosophic discussion. "You don't understand this doctrine and discipline. I do. How should you know about this doctrine and discipline? You have fallen into wrong views. It is I who am in the right."[2] We know next to nothing about the lives of these teachers. All that we know about them is that they were all recluses (samaṇas), shavelings (muṇḍakas), and wanderers (paribbājakas). They distinguished themselves from the hermits on one side, and from the Brahmin householders on the other. Thus they formed a connecting link between the ascetics practising penances and austerities in the forest and the Brahmin teachers immersed in worldly affairs. They were all bachelors as a rule and renounced all worldly ties, but they were not like the ascetics who were entirely out of touch with civic society. As a matter of fact their headquarters were established generally in the vicinity of a royal capital outside of the city wall. They differed in intelligence, temperament, character, and outlook.[1] Taking the ascetic and the Brahmin householder to represent two extremes, these teachers can be placed either in an ascending or in a descending order; ascending in regard to the degree of aloofness from sensual pleasures and descending in regard to the degree of ascetic predilection. For instance, Mahāvîra's order was one degree removed from the Buddhist order in regard to ascetic practices, and the ājivikas or maskarins one degree removed from the Jainas. Now looking the other way, the Brāhmaṇa Paribbājakas were one degree removed from the Buddhist in regard to their interest in worldly concerns associated with sensual pleasures, the Brahmin mahāsālas one degree removed from the Brahmin Paribbājakas, the writers on Statecraft (Arthakāras) one degree removed from the Dharmakāras, and so forth. This itself is a proof of the influence of the six Tirthikas upon the Buddhist order and of the influence of the orders of Mahāvîra's predecessors on his own. It enables us to make out the real significance of Buddha's famous declaration that he was a great reconciler between the two extremes, namely (i) the ideal of civic life, and (ii) the ideal of asceticism.

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[1] See my paper "A short account of the wandering teachers at the time of the Buddha." (J.A.S.B., New Series, Vol. XIV, 1918, No. 7.)

[2] Majjhima Nikāya, p. 17.

In the account given in the Sāmaññaphala Sutta, Mahāvîra is said to have laid great stress on the four-fold self-restraints (Cātuyāma Saṁvara); the term which is differently interpreted by Buddha first in relation to Mahāvîra, and secondly on his own account. In reference to Mahâvîra, the term is interpreted thus:—" A Nigaṇṭha . . . . lives restrained as regards all water; restrained as regards all evils; all evils he has washed away and he lives suffused with the sense of evil held at bay. Such is the four-fold self-restraint; and since he is thus tied with this four-fold bond, therefore is he the niggaṇtho (free from bonds) called Gatatto (where heart is gone; that is to the summit, to the attainment of his aim), Ajatatto (whose heart is kept down; that is, is under command), and Thitatto (whose heart is fixed)."[2] Buddha explained the term somewhat differently when he explained it on his own account. By the four-fold self-restraint he meant the four moral precepts, each of which is viewed in its four-fold aspect.

In the Cūlasakuladāyî Sutta of the Majjhima Nikāya,[3] we read that according to Mahāvîra, the four precepts and self-privation are the recognised roads to the blissful state of soul. With regard to the first of four restraints Buddhaghosa thought, that the Jainas did not drink cold water, on the ground that there were souls in it. The Jaina-scruples about killing may be traced to the influence of Mokkhali Gosāla, whose biological speculations gave rise to many religious problems—one of these was whether or not we were justified in taking life even for the purpose of food. We read in the Sutrakritāṅga that the Hatthitāpasas were those who used to kill every year one elephant for the purpose of food, on the ground that thereby they minimised the slaughter of life.[1] The Brahmin law-givers prohibited like Mores the eating of certain kinds of fish and flesh. But this selection has nothing to do with a total prohibition of all kinds of fish and flesh enjoined by the religious feeling of the recluses. The Upālisutta of the Majjhima Nikāya contains an interesting discussion of this subject[2] The Jaina householder Upāli pointed out that according to his master every act of killing is a cause of demerit whether the act be intentional or not. Buddha demurred to this view of Mahāvîra as he thought that a man commits no sin when the act is unintentional. It is impossible according to Buddha to abstain from killing, for even in moving about, a man is bound to put to death many lives. The Jainas took exception to the Buddhist view and an interesting account of it is given in Sutra Kritāṅga.[3]

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[1] *Ibid.*, Pt. II, Lec. I, verse 34.

[2] Jaina Sutras, pp. 74-75.

[3] Vol. II, pp. 35-36.

In the Kassapasîhanāda Sutta (Digha, Vol. I) Buddha gives a general account of the Acelakas (naked ascetics).

The same account is incorporated in the Aṅguttara Nikāya, Puggalapaññatti and other texts without any variation, which is a medley of laws and customs, that obtained amongst the various religious orders of the time, most of which were wearers of garments. This fragment can be compared with the Vaikkhānasadharmasutra also known as the Srāmaṇaka sutra which is lost for ever, and which is frequently alluded to in the older Dharmasutras now extant. In other words the Buddhist fragment is similar to the section of the Dharmasutra that professes to give a set of customary laws applicable to the Vānaprastha and Yati. The interest of the Buddhist passage lies in the fact that it invariably refers to the orders of the heretical teachers with whom we are concerned here. The Kesakamvalins were the wearers of blankets made up of hairs. As regards the Ājivika order founded by Nandavaccha, Kisasamkicca and Mokkhali Gosāla, Buddha gives a separate account in the Mahāsaccaka sutta of the Majjhima Nikāya (p. 238) which is really an abstract from the general account of the Acelakas above mentioned. The salient features of this account are given below.

The Ājivika did not wear clothes. He cherished a very tender regard for animal and all forms of life, and he developed a curious sense of freedom which led him not to obey another man's command. He was accustomed to fasting for days and weeks. In the Mahāsaccaka sutta (M.N.) a Jaina named Saccaka informed Buddha that the Ājivikas instead of leading such a moral life increased the strength and fat of their body by feeding on the best foods and drinks. In a passage of the Sutrakritāṅga[1] a Jaina accuses Makkhali Gosālaputta of immoral habits, but Buddha's account prominently brings out the fact that the Ājivikas were far from being profligate and immoral. They were on the contrary the advocates of a mode of right living (Sammā ājivo) in accordance with the principles of spiritual life, though the epithet Ājivikas was used by the Jainas and Buddhists as a catchword for a person with household ties. From the scanty account given by Buddha and the Buddhist scriptures it is absolutely clear that the Ājivikas strictly observed as a rule almost all the moral precepts binding on the Jaina and the Buddhist order. Thus we can say that the idea of right living (Sammā ājivo) was taken by the Jainas and the Buddhists mainly from the Ājivikas. The influence of the so-called heretical teachers is not only prominent in matters of practice but also in their doctrine.

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[1] Jaina Sutras, pt. II, p. 418. Aupapātika Sutta, p. 74. (Edited by Leumann.)

[2] Vol. I, p. 377.

[3] Pt. II, pp. 414-417.

Let us examine this part of our subject without going into details. Let us first examine the doctrine of Pakudha Kaccāyana (Kukudha Kātyāyana). In the Jaina and the Buddhist works his doctrine is designated differently; the name signifies various aspects and phases :—

1. "Sassatavāda" (Brahmajāla-sutta, Digha N., Vol. I, p. 1).
2. Aññajîvo (the theory of duality) annaṁsarirovādo, Sattakāyavādo ātmashasṭavādo. anikyavādo.
3. Akiriyavādo.

The logical postulate of Kavandhin Kātyāyana's philosophy is no other than the Parmenedian doctrine of Being. "Nothing comes out of nothing" (Noya uppajjae asam). What is, does not perish; from nothing comes nothing (sato nacci vināso, asato nacci sambhavo. Sutrakritāṅga (2. 1. 22). The Buddhist fragments do not make mention of this important logical principle. It is well known that this is the logical principle (Satkārya vāda) accepted in almost all the systems of Indian philosophy, notably the system of the Bhagavat Gîtā, the Sāṅkhya, the Vaisesika, and the Vedānta. Among the earlier systems we might mention Jainism, Buddhism and the philosophy of the Upanishads, particularly that of Naciketā in Kaṭhopanishat, inculcate the same principle. These led the Jaina commentators Silāṅka and others to identify the doctrine of Pakudha with the system of the Bhagavat Gîtā, the Sankhayam and some of the Shaiva systems. The ontological significance of its eternalism is summed up by Mahāvîra and Buddha in the expressions that soul and the world (Attā ca loko ca) are both eternal, giving birth to nothing new; that they are steadfast as a mountain peak, as a pillar firmly fixed. These principles are the same for ever and ever.

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[1] Jaina Sutra, pt. II, p. 411.

The epithet pluralism implies that Kaccāyaṇa sought to explain the whole of experience in the light of seven or six substances. The seven substances according to the Buddhist enumeration are earth, water, fire, air, pleasure, pain, and soul. The six substances given by the Jainas are (1) earth, (2) water, (3) fire, (4) air, (5) space, and (6) soul.

The Jaina and the Buddhist accounts differ no doubt in some respects but fundamentally we find an agreement between them.

We are led to understand that according to Kātyāyana the concrete existences are the results of the combination of the six or seven substances which perpetually unite and separate; unite by pleasure and separate by pain. Thus partly in agreement with Naciketā and partly in agreement with the Bhagavat Gîtā, Kaccāyaṇa aimed at explaining away birth and death as common phenomena in the world of experience.

The pluralism of Kaccāyana is fitly summed up in the dualism of Pippalāda in the Prasnopanishat, that is, of Sāṅkhya.

Pippalādā as is well known postulated prāṇa and rayi (that is, purusa and prakriti) the two ultimate principles relating to the explanation of all phenomena.

The logical consequence of his doctrine was fatal to modern philosophy. If the substances are uncreated, uncaused and eternally existent, and if they mechanically unite and disintegrate, the theory can ill afford to account for moral distinctions between good and bad, between right and wrong. This is the significance of the epithet akiriyavâda. Kaccāyaṇa identified thought with being. The result was that he explained away the destinies of the particulars under the glamour of the universal concepts. Both Mahāvîra and Buddha rejected the position of Kaccāyaṇa though theoretically they agreed with him that the real object of experience as a whole can never be cognised and described by appropriate symbols. Thus the influence exercised by Kaccāyaṇa upon Jainism and Buddhism was rather of a negative character.

The way for Mahāvîra and Buddha was prepared by Ajitakesakambalî whose doctrine like that of Epicurus is generally misunderstood. The negative side of Ajita's philosophy is more prominent than its positive side. In its negative side his philosophy was employed to demolish the whole ground of the Brahmanic faith and ceremonial works. Indeed it breathed an utter contempt for every thing Vedic or Brahmanic. He naively denied the possibility of re-birth and retribution. The world was just a concourse of four elements, the space being the repository of the senses, the soul being just a chemical product of matter and nothing more. Ajita rendered a great service to Indian philosophy by the positive side of his philosophy which was directed against the dualistic or pluralistic theory of Kaccāyaṇa That which is psychical is corporeal. "Tam jîvo tam sariram." Thus Mahāvîra and Buddha fitly described the main content of Ajita's doctrine. What Ajita really contemplated was not to identify body with soul, or matter with spirit, but to point out that a particular object of experience must be somehow viewed as an indivisible whole.[1]

Now the chieftain Pāyāsi who thought on the line of Ajîta stated his predecessor's thesis in clear and un-equivocal terms (Pāyāsisuttanta, Dîgha Nikāya, Vol. II). In the language of the Sthānaṅga such a doctrine is aptly designated "na santi paralokavādā." Mahāvîra and Buddha were right to suppose Ajita's doctrine to be a doctrine of non-action (Akiriyavādo), because Ajita destroyed the ultimate ground of moral distinctions by denying the possibility of personal continuity and thus deprived life of its zest. However his service to Mahāvîra and Buddha was considerable: (1) He led them to think of reality or real object as a single indivisible whole, and (2) he led them to seek for the ground of moral distinctions in the volition of mind rather than anything else.

Puraṇa Kassapa.—The Buddhist Sāmaññaphala Sutta gives a distorted, mutilated picture of the philosophical speculations of Puraṇa Kassapa. The Buddhist teachers are led by their moral predilection to judge only the moral bearing of Kassapa's philosophy. They assert that P. Kassapa rules out the play of will in our moral life from the domain of speculation. The Jainas join hands with the Buddhists in grouping Kassapa's doctrine under Akiriyavādā. The Buddhist account keeps the theoretic side of Ajita's philosophy in the background. However, an important passage of the Jaina Sutrakritāṅga[2] clearly states that his was really a theory of the passivity of soul. "When a man acts or causes another to act, it is not his soul which acts or causes to act (evam akārayu appā)." The Jaina commentators identify this doctrine with the Sāṅkhya philosophy which also posits soul as a passive principle. In the absence of documents coming down to us from Kassapa it is difficult even to imagine in what manner he conceived the part played by the soul in the conscious experience of the individual. The Sāṅkhya system speaks no doubt of soul as a mere passive spectator while prakriti performs all active functions of the body and the mind. But he tried to get over the difficulty by asserting that the presence of soul even as a passive spectator is essential to stir up energy in prakriti. Upadhî is the principle which connects body and mind with soul. Although such details of Kassapa's philosophy are unknown it is undeniable that his theory of the passivity of soul was an important step towards the development of the Sāṅkhya system from the rough outline given by Pippallāda. Thus we see that the influence of P. Kassapa's speculation upon J. and B. was rather of a negative character and the latter rejected in a body the absurdity of Kassapa's theory about the soul.

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[1] Sutrakritāṅga, 2 I. 15-17.

[2] Sutrakritāṅga, 1. I. 13.

Makkhali Gosāla.—It is not improbable that by the theory of fortuitous origin or chance (adhiccasamuppādo, ahetuappaccayavādo, akāraṇavāda, yatdricchā in the Setasatara upanishat) Buddha understood the logical postulate of the philosophy of Puraṇa Kassapa besides that of the philosophy of the Vedas and the Upanishads. Something comes into existence that was previously non-existent (ahutvā ahosi, that is to say, something comes out of nothing). This is the fundamental logical principle of Puraṇa Kassapa as Buddha understood him. The term adhiccasamuppāda is obviously the opposite of Buddha's paṭiccasamuppāda, theory of causal genesis, which is explained thus: This is that comes to be, on the arising of this, that arises, etc. Of course Puraṇa Kassapa's principle was interpreted by Buddha from the moral standpoint, something comes out of nothing means that from the soul which is uncaused arises the experience of pleasure and pain, the sense of good and bad, etc. It is curious that the theory of non-causation or chance is ascribed to Makkhali Gosāla in the Sāmaññaphala Sutta, but the incompatibility of such a theory with the general trend of Gosāla's thought needs some explanation. The Aṅguttara Nikāya has a passage where the doctrine of Puraṇa Kassapa and Mokkhali Gosāla are mixed up by Ānanda. The interest of this passage is that the theory of chance is associated with the name of Puraṇa Kassapa. Perhaps this confusion led Buddha Gautama to declare Gosāla's to be the worst of all doctrines.[1] As Mrs. Rhys Davids points out, that in this passage Buddha confounded Gosāla with Ajitakesakambalî when he said in jest that the blanket made up of hair was hot in hot weather and cold in cold weather. Judging from the line of thought followed by Mokkhali Gosāla, he was a fatalist or determinist rather than a propounder of the doctrine of chance. Everything was unalterably fixed. This was the fundamental thesis of Mokkhali Gosāla as we read in the Jaina Bhagavatî. Buddhaghosa also says that according to Gosāla things happen exactly as they are to happen, that which is not to happen does not happen.[2] It is clear from this that Gosāla maintains that everything happens according to the unalterable laws of nature, that is to say, he banishes chance from the whole of experience. He seeks to explain things as a biologist in the light of these three principles :—(1) Fate, (2) Species, and (3) Nature.

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[1] Oldenberg's Buddha, p. 70. Aṅguttara Nikāya (Siamese Edition), p. 302.

[2] Sumangala Vilāsiṇî, pp. 160-165.

The pleasure and pain which living beings experience depend partly upon past deeds and partly upon their birth and inherent nature (Niyatisangatibhāvaparinatā, Sāmaññaphala Sutta, Sutrakritanga Sutra). Gosāla's is a theory of evolution of individual things by natural transformation (parināma implied in Parinato). The Sāmaññaphala Sutta states his main thesis rather narrowly when it says that both fools and wise men alike wandering in transmigration make an end of pain (Sandhāvitvā samsaritvā dukkhassantaṁ karissanti). His doctrine is that all forms of life, all living substances, attain perfection after having gradually passed higher and higher through different types of existence which are fixed, and after having experienced pleasure and pain, peculiar to each form of existence. The highest in the scale of existence is of course a Jîna (perfect man). Now his theory of evolution differs fundamentally from Darwin's theory as it implies an evolution not of species but of individuals, from a lower species to a higher one. In working out his theory of perfection by transformation Gosāla classifies the living things in various ways and arranges them in an ascending order and he seems to give a two-fold classification, psychological and physiological. But it is implied in his expressions that organic development progresses side by side with the development of mind. He conceives infinity of time, involving a conception of kalpas (cycles), antarakalpas, meaning uniform succession of the cycles of existence ; but time for individual is finite or limited in both ways as illustrated by the simile of a ball of string which spreads out just as far and no further than it can unwind. For Gosāla there is not only a gradation of the types of existence, but also there are eight stages of development in the life of a man, at each of which the mental growth corresponds to the physical and vice versa. The theory of the gradual development of self connects Gosāla with the past, the Aitareyas in particular (Aitareya Āranyaka), and with succeeding ages, which had seen the birth of the religious philosophies of Mahāvîra and Buddha. Gosāla's biological speculations supply his worthy successors with ample food for thought, with arguments which are put by them mainly to a moral, social and, in short, to a practical use. One illustration will suffice. In the Bāseṭṭa Sutta of the Suttanipāta Buddha opposes the caste system on grounds drawn from Biology. The theory of caste or yāti is untenable as it introduces a species within a species. Buddha gives a list of species of various animals, insects and plants and holds that such a variety of species is not to be found among men (p. 115, verse 14) The theory of caste or yāti easily breaks down when we see a Brahmin and caṇḍāla don't differ in their physical constitution and can together procreate children.

A short and malicious fragment in the Sāmaññaphala Sutta tells us that Gosāla divides actions into act, word and thought; thought being regarded as half karma. This division of karma which some writers suppose to be derived from the Zendāvestā was really an indigenous growth in India and played an important part in the Jaina and Buddhist thought. As a naturalist, Gosāla lays stress on act and word; Buddha as psychologist lays stress on thought or volition (cetanā); Mahāvîra who forms a connecting link between them is said to have laid an equal stress on manokammā and kayakammā on the ground of the inter-action of body and mind (Cittaṅvayo kāyo hoti, kāyanvayaṁ cittaṁ hoti).[1] The deterministic theory of M. Gosāla constitutes a moral difficulty. If living beings are bent this way and that way by their fate, how can we make them responsible for their actions? Both Mahāvîra and Buddha think that Makkhali's theory leaves no room for the freedom of the will. That is to say, his is a doctrine of non-action (akiriyavādo) But in point of fact the moral freedom of men is not inconsistent with the deterministic theory of Gosāla, and the relation of Gosāla's theory to Indian philosophy in general and to moral philosophy in particular is that it establishes governance of law in the universe of experience. It also tacitly suggests that not only physical phenomena but also mental and moral phenomena are subject to definite laws. Thus we see that he provides his successors with a caution, that moral freedom, if there be any, must be freedom of being within the operation of laws. If will is to be operative, it must operate in accordance with the general order of things.

Sanjaya Belaṭṭhiputto.—It is still an open question whether Sanjaya B. was the same person as Sanjaya, the wanderer, the former teacher of Sariputta, who became later on the chief disciple of Buddha. Prof. Jacobi has identified the two names.[2] Of course the Belaṭṭhiputto himself was a far-famed wandering teacher of the time. There is mention of a Sanjaya in the Jaina Utra adhyāyana King of Kampilla whose teaching savours of scepticism.

There it is stated that he was converted to the Jaina faith by Gardhavāli. Supposing that Belaṭṭhiputto was no other than the wanderer and that Sariputta was the connecting link between him and the Buddha, we can show how scepticism as a philosophic method was superseded in course of time by a method which was critical. The transition did not however take place abruptly. Sanjaya's contribution to Indian philosophy was similar to that of Pyrrho in Greek tradition, who visited India and studied philosophy under the Gymnosophists in the 4th century B.C. His contribution was a negative or destructive one, as it aimed at avoiding all dogmatic conclusions. He was the first to maintain a neutral attitude towards the dogmatic views of life and things and to prove that it was impossible to offer certitude for human knowledge concerning the reality of life and things. He was the first to turn men's attention away from vain speculations and to teach that the best pathway to peace lay elsewhere, in preserving a tranquil state of mind. Thus he suggested what problems were to be excluded from the domain of speculation and he inaugurated a critical era dominated by higher ethical ideals.

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[1] M. Nikāya, Vol. I, p. 238. [2] Jaina Sutras, pt. II, p. xxix.

As philosopher, Sanjaya belonged to the sophistic period, and his doctrine was unintelligible except in relation to the teachings of Pakudha Kaccāyana and Ajita Kesakambalî.

7. The Occurrence of *Cypræa nivosa* Broderip, in the Mergui Archipelago.

By E. VREDENBURG.

(*Communicated with the permission of the Director, Geological Survey of India.*)

INTRODUCTION.

While examining the recent Cypræidæ in the rich collections of the Zoological Survey in order to compare them with the fossil species in the collections of the Geological Survey of India, my attention was arrested by a specimen labelled "*Luponia Broderipii* Gray." It has not been possible to trace the history of this specimen, the locality of which is given as "Mauritius." *Cypræa Broderipii*, a species known only from Madagascar, is a shell of the greatest scarcity and value. In 1888, when Melvill published his monograph on the genus Cypræa (*Memoirs and Proceedings* of the Manchester Literary and Philosophical Society, 4th series, Vol. I, pp. 184–252), only six specimens were known in the world's collections, and no further addition to that number appears to have been recorded since that date. It is unfortunately evident that the Calcutta specimen has been misinterpreted. The dorsal aspect of the specimen under consideration clearly shows the buff colour and pale round spots of *Cypræa nivosa* Broderip, instead of the roseate tinge and reticulated pattern of *Cypræa Broderipii*. The ventral aspect, too, exactly coincides with the available illustrations of *Cypræa nivosa*, while *Cypræa Broderipii* is distinguished by a relatively wider aperture and more elongate denticulations. Moreover, as already mentioned, the specimen under consideration is said to be from Mauritius, hitherto the only recorded habitat of *Cypræa nivosa*, while *C. Broderipii* is only known from Madagascar.

We may take it therefore as settled beyond dispute that the specimen in question belongs to the species *Cypræa nivosa*, and this identification has been the means of ascertaining, by direct comparison, that this interesting species also lives within the limits of the Indian Empire.

Amongst the collections of the Indian Museum, are two specimens from the Mergui Archipelago collected by Dr. G. Anderson, and identified by Dr. von Martens as *Cypræa vitellus* Linn. The labels at present preserved with the specimens only give the general locality "Mergui Archipelago," but in von Martens' list, the locality is recorded with further precision from Dr. Anderson's notes, as "King Island Bay." There is a rather close resemblance between *C. nivosa* and *C. vitellus*. The latter is one of the commonest species of the Indian Seas, and the likelihood of the Mergui shells being referable to that species seemed so great that they evidently were not critically examined. Their characters were greatly obscured by a rather strongly adhering thin layer of marine mud, which, owing to the supposed identity of the shell with the common *C. vitellus*, it had not been thought worth while to remove, and the specimens were returned to the Indian Museum in that same condition in which I still found them when I first examined them. On cleaning the shells it became at once evident that they do not correspond with *Cypræa vitellus*, but are specifically identical with the Mauritius specimen of *Cypræa nivosa*.

The accuracy of the locality recorded by Dr. Anderson does not admit of any doubt, and thus a most interesting addition has been made to the fauna of British India, and to the geographical range of this beautiful shell.

DESCRIPTION.

As the exact identification of these various specimens, from Mauritius and from the Mergui Islands, is matter of great importance, it may be useful to give a full description of *Cypræa nivosa* founded on the Indian Museum specimens, in place of the short diagnoses hitherto published.

CYPRÆA NIVOSA Broderip.

1827. *Cypræa nivosa* Broderip.—Zool. Journ., Vol. III, pl. iv, fig. 1.

1836. *Cypræa nivosa* Brod.—Sowerby, Conch. Ill., Cypræidæ, fig. 100, sp. 19.

1845. *Cypræa nivosa* Brod.—Reeve, Monograph of the genus Cypræa, sp. 25.

1870. *Cypræa nivosa* Brod.—Sowerby, Thesaurus Conchyliorum, Vol. IV, Cypræa, sp. 38.

1885. *Cypræa nivosa* Brod.—Roberts, Tryon's Manual of Conchology, Vol. VII, p. 182.

1888. *Cypræa vitellus* Linn.—E. von Martens, Journ. Linn. Soc., Zool., Vol. XXI, p. 186, sp. 159.

1888. *Cypræa nivosa* Brod.—Melvill, Mem. and Proc. Manchester Lit. and Phil. Soc., 4th ser., Vol. I, pp. 205, 238.

Medium-size, sub-symmetrically oval, with greatest width at about half the length of the shell, the maximum dorso-ventral thickness being also situated at about half the length, though the outline, in profile, slopes more gradually towards the anterior than towards the posterior extremity.

The small spire is more or less completely concealed by callus.

The narrow aperture divides unequally the feebly convex ventral surface. It is nearly vertical and nearly straight except near its posterior termination where it is slightly bent posteriorly towards the left. Its sides are mostly parallel except anteriorly where, in consequence of a slight curve of the columellar lip, they diverge slightly before the narrow contraction of the terminal anterior canal. The posterior notch is moderately deep, with feebly defined edges, and is deflected to the left towards the spire, the apex of which is situated in the prolongation of the axis of the notch. The anterior dorsal notch, strongly contracted at its origin, is wide and deep, strongly deflected towards the left, with a narrow, well defined rim. The external callosities of the apertural lips are feebly developed : at the anterior termination of the shell they expand slightly into short blade-like ridges on either side of the terminal notch. Elsewhere, they are not sufficiently thickened to communicate a distinctly margined appearance to the dorsal aspect of the shell.

The columella is steeply oblique, sometimes nearly vertical, in which latter case it deviates noticeably from the direction of the sloping base of the penultimate whorl. Between the straight portion of the columella, its terminal, blade-like twisted edge, and the anterior edge of the columellar lip, is a well-defined, moderately broad, rather shallow fossula.

The apertural denticulations are delicate and well defined. On the columellar side they extend deeply into the interior of the shell and are divided into two portions by a shallow, narrow longitudinal groove, on the inner side of which they occasionally bifurcate. They are continuous across the anterior fossula. The number of denticulations along the outer lip varies from twenty-five to twenty-nine according to the size of the individual. Along the columellar lip, the number is from twenty-two to twenty-five, but has no relation to the size of the shell, the largest available specimen exhibiting, indeed, the smallest observed number.

The dorsal surface is buff or dun-coloured, with crowded spots of various sizes of a pale-yellow or whitish tint. The junction of the mantle lobes is indicated by a moderately broad line, of the same pale hue as the spots, either occupying a median position, or else shifted, to a variable extent, to the right of the shell. On the ventral surface, the colour gradually fades, towards the aperture, to a pale yellowish or whitish tint similar to that of the spots on the dorsal surface, a more or less distinctly deeper colour pervading the rims of the terminal notches and the interstices between the apertural denticulations. The internal walls of the shell are of a bluish purple.

Measurements.

	Mauritius specimen.	Mergui specimens.	
Height ..	37·5 mm.	50 mm.	43 mm.
Thickness ..	23·5 ,,	30·5 ,,	25 ,,
Dorso-ventral diameter ..	22 ,,	26 ,,	22 ,,
Ratio	1 : 0·63 : 0·58	1 : 0·61 : 0·52	1 : 0·58 : 0·51
Number of denticulations in outer lip	25	29	27
Number of denticulations in columellar lip	23	22	25

Variability.—In both the Mergui specimens, the fossula is relatively narrower than in the specimen from Mauritius. This is due partly to the fact that, in the Mauritius specimen the columella is almost vertical, diverging therefore somewhat abruptly from the obliquity of the base of the penultimate whorl, and thereby contributing to increase both the width and depth of the fossula, while in the Mergui specimens, it remains more distinctly oblique. Moreover, throughout the entire length of the columellar lip, the denticulations spread internally over a wider area in the Mauritius specimen than in those from Mergui: this latter circumstance being connected with the fact that the Mauritius specimen is relativly more convex, with a relatively greater dorso-ventral diameter. The terminations of the interstices between the denticulations are more abruptly demarcated on the ventral surface in the case of the Mauritius specimen, than of those from Mergui.

So far as can be judged from the material available in Calcutta, these slight differences may indicate that the Mergui shells constitue a local race. Nevertheless, there is reason to think that the distinctions are not constant, for, in the illustration representing the ventral aspect of a Mauritius specimen, published in G. B. Sowerby's Thesaurus Conchyliorum, and reproduced in Roberts' monograph, the columella is disposed exactly as in the Mergui shells.

Of the two Mergui specimens, one is distinctly, the other slightly, more elongate than the Mauritius shell.

Comparison with Cypræa vitellus.—As may be gathered from the error of identification alluded to at the commencement of this note, this shell exhibits a certain superficial resemblance to *Cypræa vitellus*. Melvill has drawn attention to the fact that the apparently analogous ornamentation of the dorsal surface originates in a totally different way in the two species (op. cit., pp. 205–206). In the case of *Cypræa vitellus*, the brown or buff layer is deposited first, and the white spots are local accretions of opaque white enamel, analogous in effect to the "pâte-sur-pâte" decoration of a piece of porcelain. Consequently, they may feel distinctly raised to the touch, and, in a sufficiently grazing illumination, may even cast a slight shadow. In the case of *Cypræa nivosa*, the buff or brown dorsal layer is of extreme tenuity and is at first uniform, the pale patches coinciding with places where it has been subsequently resorbed.

It may be added that the spots of *Cypræa nivosa* are relatively larger, less uneven in size, and more crowded than those of *Cypræa vitellus*. The line of junction of the mantle-lobes, well developed in *C. nivosa*, is seldom observed in *C. vitellus*. The hair-like transverse striations round the margins of the dorsal surface of *Cypræa vitellus*, constituting one of the most characteristic distinctions of that species, are never developed in *C. nivosa*, in which, nevertheless, one observes the transverse cracks in the ventral and marginal portions of the enamelled callosity, which are observed in many species of Cypræidæ, and which, in the case of *Cypræa vitellus*, are evidently connected with the development of the coloured striations.

Cypræa vitellus is usually larger and less elongate than *C. nivosa*: it is a somewhat thicker, more ponderous shell. The dorsal aspect of *Cypræa vitellus* is relatively more tapering anteriorly than that of *C. nivosa* which is more symmetrically oval and therefore anteriorly more convex, less conical than in *C. vitellus*. This distinction is invariably observed in the shortest just as in the most elongate specimens of either species.

The anterior terminal notch of *Cypræa nivosa* is generally much more abruptly deflected to the left than the corresponding structure in *C. vitellus*, and has, in all cases, a much more distinctly individualized rim.

At equal dimensions the apertural denticulations of *Cypræa vitellus* are fewer than those of *Cypræa nivosa*: for instance, the outer and columellar lips carry respectively twenty-one and nineteen ridges in a specimen of *C. vitellus* from the Maldives, measuring 47 × 31 × 26 mm.; while the corresponding numbers are twenty-eight and twenty-four in a large specimen, also of the same species and from the same locality, measuring 63 × 41 × 35 mm.

CONCLUDING REMARKS.

According to Melvill (op. cit., p. 206), *Cypræa nivosa* is "very rare," and had hitherto been known only from Mauritius. The identification of the Mergui specimens has now enormously extended its range, showing it to be just as wide as that of many other wide-spread mollusca of the Indian Ocean. It is idle, for the present, to discuss whether its distribution is discontinuous or not. The species is evidently not a plentiful one; yet, owing to its curious similarity to *C. vitellus*, it is not impossible that there may have been other examples of the confusion of which we have here an instance, and that the species occurs at other localities where it may have similarly been mistaken for *Cypræa vitellus.*

In conclusion, I have to thank Dr. Annandale for allowing me the favour to examine these extremely interesting specimens.

8. Two Albino Varieties of *Cypræa erosa* Linnæus.

By E. VREDENBURG.

The two varieties of *Cypræa erosa* described in this communication were noticed during the sorting and classification of the Cypræidæ in the collections of the Indian Museum.

CYPRÆA EROSA Linnæus, var. KAOLINICA var. nov.

Description.—Medium-size, oval, moderately elongate, ventrally flattened, dorsally moderately convex, and dorsally surrounded by a moderately expanded continuous crenulated rim.

The small spire is concealed beneath a very small shallow depression near the apex of the posterior notch. The greatest width and greatest thickness are situated only slightly nearer to the posterior than to the anterior extremity of the shell. In dorsal or ventral aspect, the shape is therefore nearly oval; in lateral aspect, the declivity from the point of maximum elevation of the dorsal surface towards the anterior extremity is more gradual than towards the posterior extremity, in which latter direction the elevation, at first, scarcely decreases and then falls rapidly on approaching the posterior extremity. A few lines of growth are visible on the dorsal surface, especially on the right side. Both apertural outlets are dorsally notched. The anterior notch is of a rather shallow semi-circular shape, slightly constricted ventrally by the ridge-like terminations of the columella and outer lip. It is but slightly inclined to the vertical axis, so that its depth is not fully appreciable in a dorsal aspect. The posterior notch is narrower, deeper, and more inclined to the axis, so that it is very conspicuous in a dorsal aspect of the shell. It is situated almost symmetrically, its anterior deflection towards the left being scarcely appreciable. Its raised margins are parallel until they join round the apex of the notch in a small semi-circular arc. All round the margins and round the terminal notches, the dorsal surface is bordered by a conspicuous, though not very broadly expanded, rim, the expansion being least along the left margin. Throughout its entire length this rim is crenulated with close-set sharply prominent ridges.

The ventral surface is divided, with but a slight degree of dissymetry, by the rather narrow, nearly straight aperture, scarcely deflected posteriorly, scarcely expanded anteriorly. At its very gradual connection with the base of the penultimate whorl, the columella is practically vertical. It is terminated anteriorly by a coarse prominent, steeply twisted ridge. The columellar lip, which has a well-defined edge along the aperture, carries thirteen coarse denticulations, omitting the terminal anterior columellar ridge and the terminal posterior ridge bordering the posterior outlet. The more anterior and more posterior of these denticulations are extremely prominent, and extend externally nearly or quite close to the margin of the shell; the others do not extend so far externally. The more posterior denticulations do not extend into the interior of the aperture, but the more anterior ones extend right across the narrow anterior, internal depression, which, by their extreme prominence, they almost obliterate. The outer lip carries nineteen denticulations, counting the anterior terminal ridge forming the symmetrical counterpart to the terminal columellar edge. These denticulations are excessively sharp and prominent and extend externally over the entire width of the ventral surface on the right side of the shell, bifurcating more or less irregularly towards the margin, so that the dorsal crenulations are more numerous than the apertural denticulations.

Except for a few extremely thin lines of sienna, emphasizing some of the crenulated ridges towards the extremities of the shell, and for two pale purplish-brown marginal small patches, situated, one on each side, at half the length of the shell, distinctly visible only in the dorsal or lateral aspects, the entire shell is practically colourless; the swollen margin, ventral surface and aperture being very pale creamy-white, the dorsal surface very pale greyish-white, of an opaque porcellaneous texture, suffused with small spots of a vitreous texture which causes them to appear as slightly darker stains in the opaque porcellaneous glaze.

Dimensions :—

Height	30 mm.
Width	19 ,,
Dorso-ventral diameter	14 ,,

Occurrence.—New-Britain.

Comparison with other forms.—Although the development of the marginal rim, in the above described shell, is moderate, yet the ventral ridges and dorsal crenulations are sharper and more prominent than in any other form of this species, constituting sharper ridges than in the variety *straminea* Melv., which is also remarkable for the strong development of its denticulations. The uniformly white colour, recalling a piece of glazed white porcelain, is entirely different from that of any hitherto described form so far as can be ascertained from available information. Judging from the highly glazed condition of the shell, and also the presence of the lateral patches, it is extremely unlikely that the specimen can be weathered and bleached, which, moreover, would not account for the characters of the vitreous dorsal spots. Such vitreous spots are occasionally seen in normal specimens in which, however, they alternate with the usual opaque spots, besides which they are always situated on a coloured ground. In the present instance, there is a complete reversal of the usual disposition, the ground having acquired the opaque whiteness that usually characterises the spots.

CYPRÆA EROSA, Linnæus, var. PURISSIMA var. nov.

In shape, this shell corresponds with the previously described variety, except that the dorsal rim is narrower. The ventral ridges and dorsal crenulations are less extremely prominent than in the previously described variety.

The entire shell is of a brilliant pure white and of a porcellaneous texture. Even the usual lateral blotches are missing. The dorsal spots are scarcely visible, being merely still more opaque and therefore still whiter than the surrounding ground.

Dimensions :—

Height	32 mm.
Width	19 ,,
Dorso-ventral diameter	14 ,,

Occurrence.—According to a detached label, this shell is from Moreton Bay (Queensland). A slight doubt as to the correctness of this occurrence is due to the fact that in the same box containing this shell are two specimens of *Cypræa eburnea* Barnes, to which the label undoubtedly refers. The simultaneous occurrence of two intensely white forms belonging to different species, if correct, is a remarkable coincidence ; only, as the person who sorted the specimens has evidently mistaken the shell under consideration for *Cypræa eburnea*, there remains a suspicion that it has been added to the Moreton Bay specimens of *C. eburnea* though it might have been from a different locality.

Comparison.—This shell is still more intensely white than the previously described variety *kaolinica*. The only other *Cypræa* known to exhibit an equally white colour is *Cypræa eburnea* Barnes, which is readily distinguished by its pear-shaped outline, the feebly developed dorsal rim, the much less pronounced ventral outer extension of the apertural denticulations.

Note.—The variety *subalba* Smith, from Aden, is presumably partly white or pale-coloured. It is described in the Nautilus (Vol. XXVI, p. 78), a publication not available in India.

9. The Occurrence of *Cypræa piriformis* Gray, in the Mergui Archipelago.

By E. VREDENBURG.

(*Communicated with the kind permission of the Director, Geological Survey of India.*)

In the list of molluscan species collected by Dr. J. Anderson in the Mergui Archipelago, published in 1888 in the Journal of the Linnean Society (Zoology, Vol. XXI), Dr. von Martens has referred one specimen to *Cypræa xanthodon* Gray, a particularly characteristic Australian form which has never been authentically recorded from the Indian region (*loc. cit.*, p. 186, sp. 165). The specimen, probably on account of its relatively small dimensions, has been labelled as immature, a conclusion contradicted by the remarkably strong development of the denticulations, the completely formed terminal notches and the fully developed colour-scheme. The specimen is in a perfectly fresh condition, but, like most of the specimens returned to the Indian Museum by Dr. von Martens, had never been cleared of the layer of marine mud which obscured its characters and which, as in a previously recorded instance,[1] has been the cause of an inexact determination.

On cleaning the shell, it was found to be a perfectly fresh and remarkably perfect specimen of the beautiful *Cypræa piriformis* Gray, one of the rarest and most highly prized forms of the genus.

The specimen is smaller than the average, but with an intensely polished outer enamel, and of remarkably vivid colouring. Its measurements are as follows:—

Height	..	..	..	22 mm.
Width	..	..	..	12·5 ,,
Dorso-ventral diameter			..	10 ,,

The ascertained occurrence of this beautiful shell in the Mergui Archipelago is of great interest, but is not unexpected, as the species was already known from Ceylon and from North Australia.

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[1] Jour. As. Soc. Beng., Vol. XV, N.S., p. 137.

10. Observations on the Intra-uterine Embryos of Elasmobranchs.

By T. Southwell, A.R.C.S., F.Z.S., *Director of Fisheries, Bengal and Bihar and Orissa*; and B. Prashad, D.Sc.

A study of the intra-uterine embryos of Indian Elasmobranch fishes has resulted in the elucidation of some very interesting problems, and in this paper we propose giving a general account of this work.[1]

As is well known, both oviparous and viviparous forms are present amongst the Elasmobranchs, and the origin of viviparous from the oviparous forms is a matter of very great zoological interest. Fortunately there exist among the living Elasmobranchs almost all grades in the evolution of these forms, and by a study of these one is able to conjecture as to the probable line along which such evolution has taken place. The embryos in the course of the intra-uterine period of their existence develop special structures which adapt them for the absorption of food material from the maternal uterine tissues; further they pass through a number of different stages which seem to be of the nature of recapitulatory stages and possibly represent the phylogenitic changes that have taken place in the history of the group.

In the oviparous Selachii like *Scyllium* and *Raia* there is no connection whatsoever between the mother and the embryo. A part of the oviducal wall is specialized as the shell-gland and secretes an egg-case round each of the eggs; while another part higher above the shell-gland portion secretes a quantity of yellowish fluid round the eggs and this is absorbed by the embryo during its development. In other Selachians like *Acanthias*, *Scymnus*, etc., a shell is developed round the egg, but the egg-cases so formed, instead of being laid into the sea are retained in the oviduct and the embryos, after developing to a certain stage come to lie freely in the oviduct, which thus serves as a true uterus. Amongst these forms also the uterine wall secretes a nutritive fluid which is absorbed by the embryos. A still greater advance is seen in the Selachians in which no shell whatsoever is developed; on the other hand a special connection is established between the embryo and the maternal uterine tissue by the transformation of the yolk-sac into a placenta. As an example of this class may be cited the common Indian sharks of the genus *Scoliodon.* We have thus reached a stage where we find the formation of a definite placental connection between the embryo and the mother for the absorption of food. A still more interesting modification is to be seen in the aplacental viviparous Elasmobranchs which absorb, or injest, the nutritive secretions of the uterine glands through special structures developed either by the embryo or the maternal uterus or by both. In these forms though there is no definite placental connection, still the nutritive material from the uterus reaches the embryo in an indirect fashion.

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[1] For anatomical and other details and literature refer to *Rec. Ind. Mus.*, XIX, pp. 215–241 (1919).

As to the origin of the placental and aplacental viviparous forms our views are entirely in agreement with those of Alcock, and may be summed up as follows:—Placental viviparity arises directly from the oviparous condition by the large yolk-laden egg being retained in the uterus without the secretion of an egg-case round it; the large yolk-sac now forms a simple type of connection with the uterine wall, and the yolk-stalk becomes transformed into the placental-cord for the transference of the food material from the mother to the embryo. Various intermediate stages in the formation of a highly evolved arborescent type of placenta from the very simple yolk-sac placenta are also represented amongst the living forms. In aplacental viviparity, on the other hand, it seems that the condition is to be derived directly from the oviparous and not from the placental viviparous forms. Here no placental connection ever occurs, but in the earlier stages of their intra-uterine existence the embryos develop large branchial filaments for the absorption of the secretion of the maternal uterine-tissue, which at this stage surrounds the embryos, and also help in absorbing the yolk contained in the massive yolk-sac of the embryo itself. Later in development, and before the whole of the yolk has been absorbed, the branchial filaments disappear and large trophonemata or 'starp-shaped filaments' are developed from the maternal uterine wall. These trophonemata become enlarged in special places and entering the large spiracles of the embryo directly pour the uterine secretion into the alimentary tract of the embryo. It will be clear from the above that in the Elasmobranchs the evolution of the viviparous from the oviparous forms has taken place along two definite lines—(i) placental, (ii) aplacental.

In passing, one cannot help remarking on the existence of the various types of oviparous, placental and aplacental viviparous forms amongst the Elasmobranch fishes.

We will now go on to give a short general account of some of the accessory structures developed by the viviparous forms.

Placenta.—It should be clearly understood that the placenta is of the true yolk-sac type, and that in these forms we can trace a regular series in the evolution of the arborescent, spreading type of placenta of the more advanced forms from the simple yolk-sac type of the others. We have in the course of our studies been able to distinguish three distinct grades.

(i) In *Scoliodon sorrakowah* and *S. palasorrah* we meet with the least modified type. Here the typical rounded or slightly ovoid yolk-sac develops at its free extremity a number of small protruberances which become embedded in the uterine wall and form a very simple type of placenta. The connection between the embryo and the mother is not of a very intimate character.

(ii) The placenta of *Mustelus laevis* and of a species of *Carcharias*, figured by Muller, is of a more advanced type. Here we find a distinct placenta-like interdigitation of folds of the yolk-sac, the villi-like projections fitting into corresponding depressions in the mucous membrane of the uterus, similar to the cotyledons of the placenta of the Ruminants in Mammals.

(iii) The more advanced arborescent type of placenta, many grades of which also occur, is to be seen in a large number of Selachii. When fully evolved it is a fairly large spreading structure formed by continued subdivision of the distal end of the placental cord and the remains of the yolk-sac. The blood-vessels in the placental-cord divide again and again to supply the large placenta, which thus becomes a highly vascular structure. It is in close connection with a similar flat and highly vascular portion of the uterine wall. The food in these forms is obtained by the embryo from the mother through the vascular system.

Placental cord and its appendages.—The placental cord of the Selachii results from a transformation of the yolk-stalk. When the yolk in the yolk-sac is exhausted, and the placenta is being formed from the yolk-sac the connection between the yolk-sac and the alimentary canal of the embryo is cut off. The cavity of the yolk-stalk is squeezed out and its place taken up by a large artery and a vein ; the connections of which with the vascular system of the embryo in the placental and aplacental forms are the same. It is in this way that a transformation of the yolk-stalk into placental cord takes place with the modification of the yolk-sac into the placenta. It may be remarked here that in their descriptions of the embryos, some authors have designated the yolk-stalk of the aplacental Batoids as the umbilical cord. This name, in view of the fact that in the aplacental forms no placental connection is ever developed between the foetus and the maternal uterine tissue, and further the origin of the aplacental forms from oviparous and not the placental viviparous forms, is quite a wrong name. The walls of placental cords of the sharks are, in a number of cases, covered over by *appendicula* or special processes. In the large number of species studied we have been able to trace a nearly complete series in the evolution of the long thread-like, single, or branching appendicula from mere projections of the wall of the placental cord. It should, however, be noted that though we have a nearly complete series in the development of the long appendicula, this does not give us any clue as to the origin or evolution of these structures, nor does it indicate any near relationship amongst these forms, because in the species with the best developed appendicula the placenta is of the most primitive and least evolved type and vice versa. Indeed the last mentioned fact seems to show that the forms with less highly organized type of placenta requiring some other mode of absorption of food have developed these additional structures or appendicula, which under these circumstances would be of the nature of acquired or adaptive structures.

Branchial-filaments.—In the early stages of the intra-uterine embryos of many Batoids, large numbers of delicate and much elongated branchial-filaments are seen protruding out of the branchial openings of the embryos. These filaments are the greatly elongated gill-processes, coming out of all the gill-slits except the spiracles. In some cases they are so numerous as to form about one-third the mass of the whole embryo. In the later stages the branchial clefts are tightly closed and there are no filaments, these apparently having atrophied long before. These structures have been called by such diverse names as branchial or gill-filaments, external gills or gill-filaments, and trophonematous filaments. In our opinion the name branchial filaments is most suited, as besides showing their origin, it does not suggest or imply any function for these structures. As to their function Alcock considered them to be of use for the absorption of the nutritive material in the yolk-sac of the embryo. Their very elaborate vascular supply on the other hand points to their being of the nature of respiratory structures in addition to having a probable secondary function of the absorption of yolk and the secretions of the maternal uterine wall, but it must be admitted that we are at present far from a proper understanding of the physiology of nutrition and respiration of these fishes.

It will be seen from what has been stated above that in the placental and aplacental viviparous Elasmobranchs various peculiar devices are adopted for the absorption of food during the life-history of a single individual.

11. Ancient Hindu Spherical Astronomy.

By G. R. Kaye.

1. The following notes are the result of an attempt to summarise, with the aid of modern mathematical formulae, the fundamental portions of the classical Sanskrit astronomical texts. The results achieved, even though they may not be perfectly complete, are, it is thought, worthy of publication.

The texts dealt with are the *Āryabhaṭīya* (A.D. 498), the *Pañchasiddhāntikā* (circa A.D. 550), the *Brāhmasphuṭasiddhānta* (A.D. 628), and the later *Sūrya Siddhānta* (circa A.D. 1000). The period covered, it will be noticed, corresponds pretty closely with the period that was characterised by a remarkable rennaissance of literature, art and science in India; and the following paragraphs indicate in a somewhat forcible manner, but, of course, only in part, the scope of intellectual activity in India in that early time. This summary may, indeed, be looked upon as an aid to the study of a particular intellectual phase of that period; and this ancillary function has largely determined the form of presentation of the material.

Spherical Trigonometry.

2. Although no formal spherical trigonometry is exhibited in any text, the early Hindu astronomers were obviously acquainted with principles that enabled them to solve spherical triangles. This statement, however, requires some qualification. The Hindu school of mathematicians preferred to deal in lengths rather than angles; they had no geometry of angles; and their rules are in all cases stated as results without reference to the methods by which they were obtained, and these methods are consequently buried in obscurity. As these ancient astronomers were chiefly interested in results it is possible, if we assume that they obtained these results from outside sources and were not interested in the mathematical principles involved, to conceive that they were not acquainted with those principles; but the assumption is rather a strain, as there are too many formulae based upon the spherical triangle to be explained away. We may therefore certainly say that traces of the principal formulae of spherical trigonometry are found in the Hindu texts.* On the other hand there occur indications which point to some lack of a knowledge of the

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* See also *A. v.* **Braunmühl** *Vorlesungen über Geschichte der Trigonometrie*, p. 41.

mathematical principles involved, and we may certainly say that these principles were treated with a certain amount of indifference. In several of the astronomical rules summarised below there are then at least traces of the following rules of spherical trigonometry :—

$$\text{(i)} \qquad \cos c = \cos a \cos b + \sin a \sin b \cos C$$

$$\text{(ii)} \quad \sin A \sin c = \sin a \sin C$$

$$\text{(iii)} \quad \cos A \sin c = \cos a \cos b - \sin a \cos b \cos C$$

where A, B, C are the angles of a spherical triangle, and a, b, c are the corresponding opposite sides.

The Indian astronomers employed the sine function principally, and the versed sine ($= 1 - \cos a$) occasionally; they never employed the tangent function; and generally, but not always, preferred to employ the sine of the complementary angle rather than the cosine function.

3. In translating the Hindu rules into modern notation it must be borne in mind that the Hindu sine function is a length, not a ratio; and denoting the Pauliśa sine by $\sin P$, the Āryabhaṭa sine by $\sin A$, the Brahmagupta sine by $\sin B$ and the modern sine by $\sin a$, where the arcs P, A B, and a are the same, we have

$$\frac{\sin P}{p} = \frac{\sin A}{a} = \frac{\sin B}{b} = \sin a$$

a, p and b being the Āryabhaṭa, Pauliśa and Brahmagupta radii, measured in different units. When actual values for the sines are given, which is very seldom in the texts,[*] we have

$$\frac{\sin P}{120} = \frac{\sin A}{3438} = \frac{\sin B}{3270} = \sin a.$$

4. It should also be borne in mind that the rules are always expressed fully in words, and that the more complicated formulae are built up in stages. Here is a fairly typical example[†] in which the stages are marked A, B, C, etc.

> "(A) If the radius be multiplied by a given shadow and divided by the corresponding hypotenuse, the result is the sine of the zenith distance. (B) The square-root of the difference of the square of that and the square of the radius is the sine of the altitude, (C) which multiplied by the radius and divided by the sine of the co-latitude gives the 'divisor.'

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[*] The *Pauliśa Siddhānta* (PS.—iv, 24) gives $\sin 24° = 48' 48''$, while the *Sūrya Siddhānta* (ii, 28) gives $\sin 24° = 1397'$, the modern value being 0·4067 approximately. Now $·4067 \times 120 = 48·904$ and $·4067 \times 3438 = 1398·2$.

[†] From the *Sūrya Siddhānta*—iii, 37–39. See paragraph 6 (*b*) iv, below.

(D) Multiply the latter by the radius and divide by the radius of the diurnal circle and the quotient is the sine of the *unnata*: (E) this, then, being subtracted from the day measure and the remainder turned into arc by means of the tables of versed sines, the final result is the hour angle."

The operations indicated are:

(A) $\sin z = rs / H$, (B) $\sin (90° - z) = \sqrt{r^2 - A^2}$, (C) $rB / \sin (90° - \phi)$, (D) $rC / r \cos \delta$, where $r \cos \delta$ is the 'radius of the diurnal circle,' (E) $r + r \tan \phi \tan \delta - D$, where $r + r \tan \phi \tan \delta$ is the 'day measure.'

This means

$$\begin{aligned} \text{versin } h &= r + r \tan \phi \tan \delta - C / \cos \delta \\ &= r + r \tan \phi \tan \delta - rB / \cos \delta \cos \phi \\ &= r + r \tan \phi \tan \delta - r \cos z / \cos \delta \cos \phi \end{aligned}$$

or $$\cos h = \cos z / \cos \delta \cos \varphi - \tan \phi \tan \delta$$

when $r = 1$.

Definitions.

5. (*a*) In figure 1 the horizon (*kshitija*) is represented by NES, the equator (*vishuvadvṛitta*) by EQ, the pole is P, the zenith (*dṛis*) is z, and FGR is the diurnal path of a star. The angle $PON = ZOQ = \phi$ is the terrestial latitude (*aksha*) of the place O, the angle $ROQ = \delta$ is the declination (*krānti*) of the star, and the angle $EOF = a_0$ is its amplitude when on the

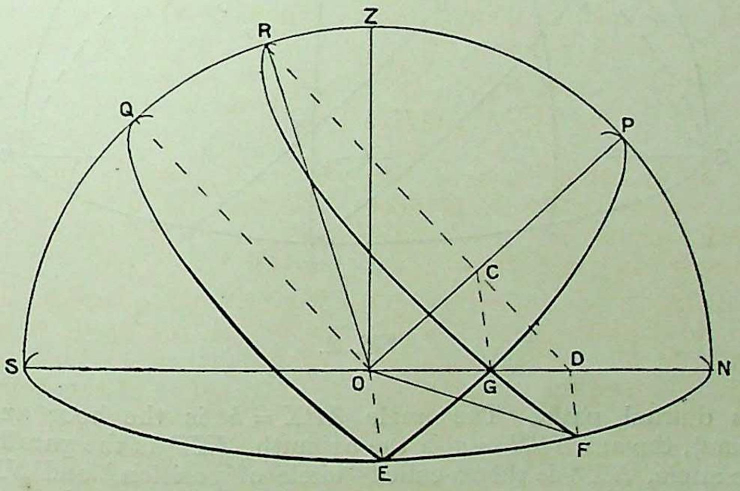

Fig. 1.

horizon. The circle PGE, passing through the pole and the east and west points, is the so-called 'six-hour circle' (*unmaṇḍala*).

Denoting the radius QO by r we have

(i) $RC = r \cos \delta$, the 'day radius' (*dinavyāsadala*)

(ii) $CD = r \sin \delta \tan \phi$, the 'earth sine' (*kshitijyā*)

(iii) $\sin a_0 = OD / OF = \sin \delta / \cos \phi$

(iv) $RD = r \cos \delta + r \sin \delta \tan \phi = r \cos \delta \ (1 + \tan \phi \tan \delta)$ where $r\ (1 + \tan \phi \tan \delta)$ is termed the 'day measure' (*antyā*)

(v) $\sin GCF = CD / CF = CD / RC = r \sin \delta \tan \phi / r \cos \delta = \tan \phi \tan \delta$, and $GCF = \Delta a$ is termed the 'ascensional difference' (*chara*).*

(*b*) In figure 2, NES is the horizon, $NZMS$ is the meridian (*yāmyottaravṛitta*), QKE is the equator, ZE is the prime vertical (*samamaṇḍala*); X is the position of a star, and MXF is its diurnal path. The angle $ZPX = h$ is the hour angle (*nata*), the arc $NSH = a$ is the azimuth, ZXP is the parallactic angle, NXS is the so-called 'circle of position,' and $NXP = \xi$ is the *aksha valana*, or 'deflection due to latitude.'

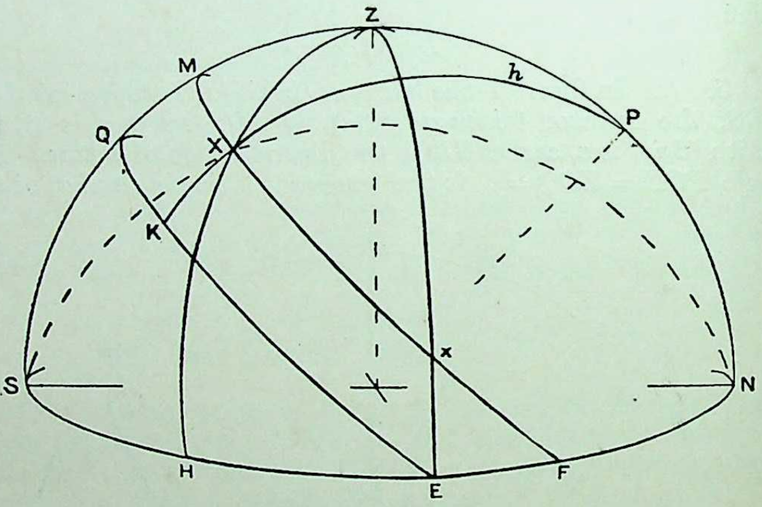

Fig. 2.

(c) In figure 3, $Q \Upsilon R$ represents the equator and $C \Upsilon L$ the ecliptic (*apamaṇḍala*). The point Υ is the so-called 'first point of Aries.' The sun moves along the ecliptic in the direction ΥdL. The circle PXP' is a declination circle (*krāntivṛitta*) through the star X, and KXK' is a circle of latitude (*vikshepa*). In some Hindu texts Υa instead of Υd is termed the longitude of X, and Xa instead of Xd is termed the latitude. These are sometimes called the 'polar' or 'false' longitude and

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* The hour angle $RCF = 90° + \Delta a$, consequently $\cos h = - \sin \Delta a = - \tan \phi \tan \delta$.

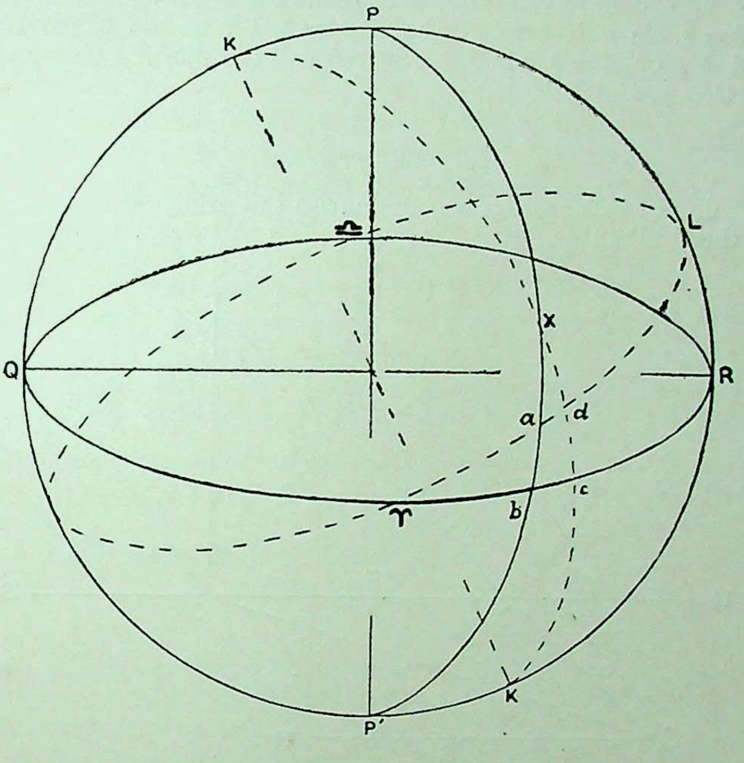

Fig. 3.

latitude. The obliquity $\omega = L\Upsilon R$ is only indicated as the maximum declination of the sun, or LR, and is generally assumed to be 24 degrees. Denoting the true longitude Υd by λ and the false longitude Υa by λ', and similarly the true (dx) and false (ax) latitudes by β and β', and the angle Υab by A, and noting that the angle of $a\Upsilon b = \omega$, and $\Upsilon ba = 90°$ and also $\Upsilon dc = 90°$, we obtain from the spherical triangles Υab and xda

$$\text{(i)}\ \tan A = \cot \omega / \cos \lambda', \qquad \text{(ii)}\ \sin A = \sin \beta / \sin \beta',$$

$$\text{(iii)}\ \sin \lambda - \lambda' = \tan \beta / \tan A.$$

(*d*) In figure 4, $OA = g$ represents a vertical gnomon (*śanku*), NOS and EOW are the north and south and east and west lines through the base of the gnomon. If $OF = e$ is the equinoctial noon-day shadow (*vishuvadbhā*) for northern latitude ϕ, then FG, parallel to OW, is the locus of the equinoctial shadow, and the line $BO = s$ represents the shadow at a time when the sun's declination is south. Draw BH parallel to NS and denote BG by A; then $BH = A + e$. The line $BH = s. \sin \theta$ is termed the *bhuja*, $BC = s. \cos \theta$ the *koṭi*, and BG or $A = s. \sin \theta - e$ is termed the *agrā*.* The angle $FAO = \phi$, and $BAO = z$.

Rules and problems.

6. In this section we summarise the principal rules given in the siddhāntas.

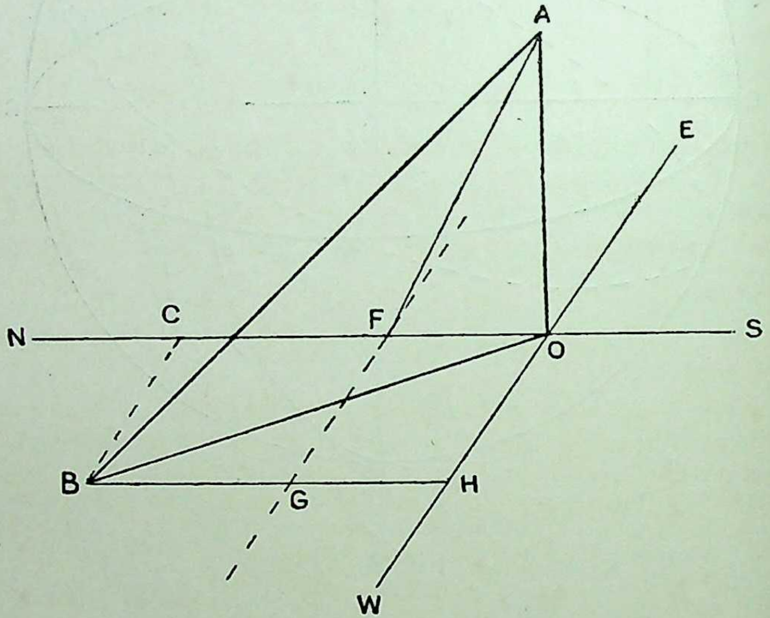

Fig. 4.

(*a*) *The gnomon.*—From figure 4 the following are obtained:—

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* $A = \pm (s \sin \theta - e)$ when B is north of EW (the positive sign to be taken when it is north of FG).

(i) Angle $CAO = z_n = \phi - \delta$

(ii) ,, $FAO = \phi$

(iii) $\tan \phi = OF / OA = e / g$

(iv) $\sin z = BO / BA = s / H$

(v) $\cos z = AO / BA = g / H.$

(*b*) *The hour angle, azimuth and zenith distance.*—In the triangle XPZ in figure 2 we have $ZP = 90° - \phi$, $XP = 90° - \delta$, $ZX = z$, $ZPX = h$ and $XZP = 360° - a$. From formulae i-iii in paragraph 2 we obtain

(i) $\cos z = \sin \phi \sin \delta + \cos \phi \cos \delta \cos h$

(ii) $\sin a \sin z = - \cos \delta \sin h$

(iii) $\cos a \sin z = \cos \phi \sin \delta - \sin \phi \cos \delta \cos h$

and from these we get

(iv) $\cos h = \cos z / \cos \phi \cos \delta - \tan \phi \tan \delta$

$= (g / H \cos \phi - \sin \delta \sin \phi / \cos \phi) / \cos \delta$

(v) $\cos a = \sin \delta / \sin z \cos \phi - \tan \phi / \tan z.$

At the moment of rising, since $z = 90°$, we have from (iv)

(vi) $\cos h = - \tan \phi \tan \delta$

or, if $h = 90° + \Delta \alpha$ we get

(vii) * $\sin \Delta \alpha = \tan \phi \tan \delta$

where $\Delta \alpha$ is called the ascensional difference (*chara* or 'variable).'

(*c*) *Declination and longitude.*—In figure 3, if a is the position of a star on the ecliptic then Υa is its longitude λ, its declination $\delta = ab$, and its maximum declination $\omega = LR$ or $L\Upsilon R$. Solving the right-angled triangle Υab we have

$$\sin \delta = \cos a\Upsilon b \sin a\Upsilon$$
$$= \cos \omega \sin \lambda.$$

(*d*) *To find the zenith distance when the star is on the prime vertical.*—If the star is on the prime vertical, that is at x in figure 2, then $a = 270°$ and $\cos a = 0$ and from (*b*) (i) and (iii)

$$\cos z = \sin \delta / \sin \phi = \sin \lambda \sin \omega / \sin \phi.$$

(*e*) *The koṇaśanku.*—Again in figure 2, if $SH = 45°$ then $a = 180° + 45$ and $\cos a = - 1 / \sqrt{2}$, and from the triangle XPZ or b (v) we get

---

* **Of these only (iv) and (vii) appear explicitly in the texts.**

$$\sin\delta = \cos z \sin\phi + \sin z \cos\phi \cos a$$
$$= \cos z \sin\phi - \sin z \cos\phi / \sqrt{2} \quad \text{or}$$
$$\cos^2 z\,(2\tan^2\phi + 1) - 4\tan\phi \cos z \sin\delta / \cos\phi$$
$$+ 2\sin^2\delta / \cos^2\phi - 1 = 0.$$

Substituting in this e/g for $\tan\phi$ and $\sin a_0$ for $\sin\delta/\cos\phi$, and solving for $\cos z$, we get

$$\cos z = \frac{ge \sin a}{e^2 + g^2/2} \pm \sqrt{\frac{g^2\,(\frac{1}{2} - \sin^2 a_0)}{e^2 + g^2/2} + \frac{(ge \sin a_0)^2}{(e^2 + g^2/2)^2}}.$$

(*f*) *The agrā.*—Substituting $\sin a_0$ for $\sin\delta/\cos\phi$, s/H for $\sin z$, and g/H for $\cos z$ in (*b*) (v), we get

$$\text{(i)}\quad s\cos a + e = H \sin a_0.$$

For the point B in figure 4 we have ϕ and z both positive, δ negative (which makes $\sin a_0$ negative), $a = 90° + BOH$ and $\cos a = -\sin BOH$. Consequently (i) becomes $s\sin BOH - e = H\sin a_0$. But $\sin BOH = (BG + GH)/BO = (A + e)/s$ and $s\sin BOH - e = A$. Consequently

$$\text{(ii)}\quad A = H\sin a_0 = H\sin\delta/\cos\phi,$$

where A is the agrā—which may be defined as the perpendicular from the extremity of the shadow to the equinoctial line.

(*g*) *The dṛikshepa.*—The central ecliptic point, or point on the ecliptic that is 90 degrees from the horizon is termed the

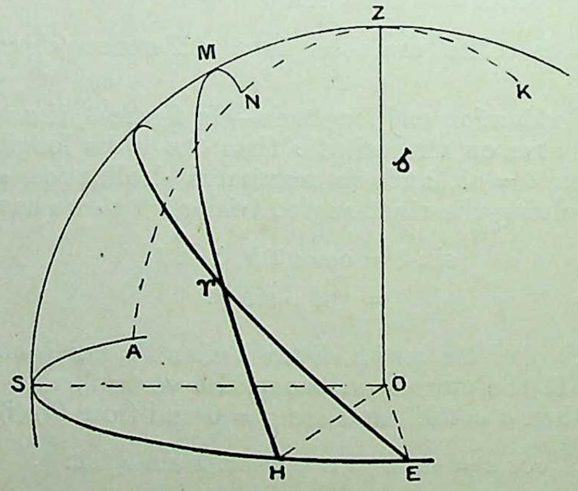

Fig. 5.

nonagesimal point or *tribhonalagna* or *vitribha*, and the sine of its zenith distance (z_e) is termed *dṛikshepa*, and its cosine *dṛiggati*.

The rule for the *dṛikshepa* or $\sin z_e$ is evolved thus: In figure 5 where $N \Upsilon H$ is the ecliptic, ΥE the equator, EHS the horizon, ZMS the meridian and N the nonagesimal, we have $H \Upsilon N = 90$ degrees, $H \Upsilon E = \omega$, and $\Upsilon EH = 90^\circ - \phi$. From the triangle ΥHE we obtain $\sin HE \sin \Upsilon EH = \sin \Upsilon H \sin H \Upsilon E$, or

$$\text{(i)}\ \sin a_l = \sin \lambda_l \sin \omega / \cos \phi,$$

where a_l denotes the amplitude of the rising sign or lagna (H) and λ_l denotes its longitude (ΥH). Also $HE = SA$, since $ES = 90^\circ$ and $HA = 90^\circ$ and therefore the angle $MZN = a_l$. Now in the triangle ZMN we have $MZN = a_l$, $ZN = z_e$, $ZM = z$, and the angle $ZNM = 90^\circ$; and consequently $\sin ZN = \sin ZMN \sin ZM$, or $\sin z_e = \sin ZMN \sin z$. If now ZMN be considered a plain triangle we have $\sin ZMN = \cos MZN = \cos a_l$ and finally

$$\text{(ii)}\ \sin z_e = \sin z \cos a_l$$
$$= \sqrt{\sin^2 z - \sin^2 z \sin^2 a_l}$$

as given in the texts.

(*h*) *The valana.*—In figure 6, NES is the horizon, CX the ecliptic, NXS is the circle of position of X, P is the pole of the equator and K is the pole of the ecliptic; $PX = 90^\circ - \delta$ is the hour circle of X and $XPZ = h$ is its hour angle, Z being the zenith; $PN = \phi$ and $PK = \omega$.

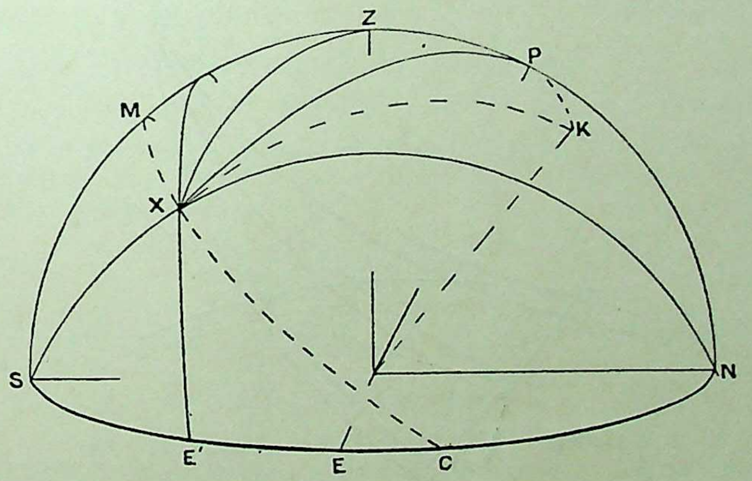

Fig. 6.

According to the *Pauliśa siddhānta* the *valana* or angle of position of the point X on the ecliptic is the angle $NXP = \xi$,* but later siddhāntas more correctly imply that it is the angle $NXK = \xi - \chi$, that is, the angle between the circle of position and the circle of latitude, or, what is the same thing, the angle CXE' between a circle (XE') parallel to the prime vertical and the ecliptic.

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* Apparently with reference to the use of the 'polar latitude' (see § 5c).

In the triangle PXK since $KXP = \chi$, $PK = \omega$, $KX = 90°$ and $XP = 90° - \delta$, we have

$$\text{(i)} \quad \sin \chi = \sin PX \sin XKP / \sin XP$$
$$= \sin \omega \sin (90° + \lambda) / \cos \delta$$

and in the triangle NXP

$$\text{(ii)} \quad \sin \xi = \sin PNX \sin \phi / \cos \delta,$$

for which the text substitutes $\sin h \sin \phi / \cos \delta$. The angle $NXP = \xi$ is termed *aksha valana*, or 'deflection due to latitude,' and the angle χ is termed *āyana valana*, or 'deflection due to obliquity.'

(*i*) *The dṛikarma and planetary conjunctions.* By some of the later Hindu astronomers the subject of planetary conjunctions is considered. Two planets are said to be in conjunction *when they are on the same circle of position* (that is on the same secondary to the prime vertical), and on such a circle the stars rise and set simultaneously. Unless, however, the circle of position coincide with a circle of latitude, the two stars cannot

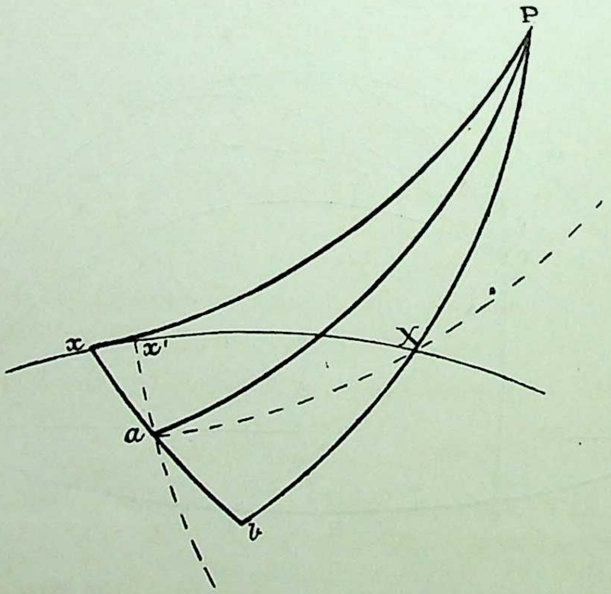

Fig. 7

have the same true longitude, and it becomes necessary to find the longitude of the point of intersection of the circle of position with the ecliptic, when the true longitude of the star is known.

In figure 7, $x'a$ is a portion of the ecliptic, and aX and $x'X$ are respectively the circle of latitude and the circle of position through the heavenly body at X. The problem is to find the longitude of x' when that of a is known.

Let xab be the day circle of the point a and x the point of intersection between this day circle and the circle of position, then the first step in the solution of the problem is to assume that ax is sufficiently nearly equal to $x'a$ for the purpose in hand.

Draw the declination circles Px, Pa, Pb through the points x, a, and X, the last cutting the day circle in b, and denote the angles aPb and xPb by ψ_1 and ψ_2.

We have $xa = xb - ab$, and it may be noted that at the solstices aX and aP coincide and ab disappears. The process of determining ab is therefore called *ayanadṛikarma*; while at the equator aX and Pb would coincide and then xb would disappear and the process of determining xb is termed *akshadṛikarma*.

(i) *Ayanadṛikarma.*—The angle PaX between the circle of declination Pa and the circle of latitude aX is the ayanavalana (see § (h)) and we have

$$\begin{aligned}\sin \psi_1 &= \sin aX \sin PaX / \sin PX \\ &= \sin \beta \sin \chi / \cos \delta.\end{aligned}$$

(ii) *Ayanadṛikarma.*—The angle PxX is nearly equal to the akshavalana, ξ, and $\sin xX = \sin bX / \sin Xxb$ and $bX = \beta'$, the polar latitude, so we have

$$\begin{aligned}\sin \psi_2 &= \sin xX \sin PxX / \sin PX \\ &= \sin \beta' \sin \xi / \cos \delta \sin Xxb \quad \text{nearly}\end{aligned}$$

and at the horizon the angle Xxb is equal to the colatitude of the place.

The ascensional difference.

7. At the equator, where the horizon is at right angles to the equator, the apparent daily paths of the stars are circles at right angles to the horizon, and we have *right ascensions*; while at the poles the apparent daily paths are parallel to the horizon; but at any other latitude (ϕ) they are inclined to the horizon and we have *oblique ascensions*. The Greek astronomers paid considerable attention to the relation between right and oblique ascensions and determined therefrom correct rules for the calculation of the length of the day, rules and tables connected with the rising sign or ascendant or horoscope,

culminating signs, and problems in which the sun's declination and terrestrial latitude were involved.

In figures 8 and 9 the horizon is represented by AC, the ecliptic by $C\Upsilon$ and the equator by $A\Upsilon$. The arc ΥA is termed the ascensional equivalent of ΥC, the arc ΥA being that portion of the equator and ΥC that portion of the ecliptic that rise in the same period. At the equator CB coincides with CA and $\Upsilon A = \Upsilon B$ is the equivalent of ΥC in right ascension, or the right co-ascendant; for the latitude ϕ the equivalent in oblique ascension (or oblique co-ascendant) is ΥA, and AB is the *ascensional difference*.

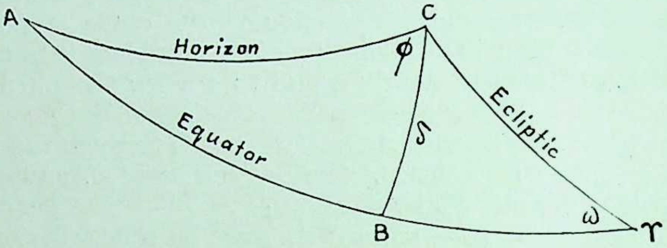

Fig. 8.

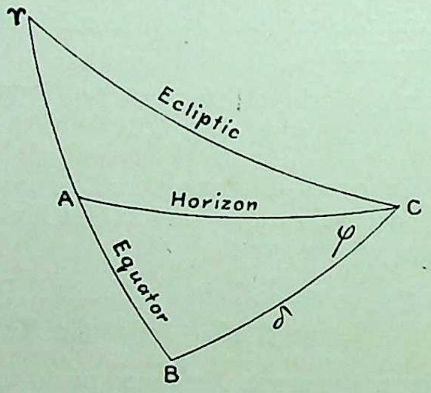

Fig. 9.

In the triangles ΥABC we have $\Upsilon C = \lambda$ or $360° - \lambda$, $CB = \delta$, the angle $A\Upsilon C = \omega$, and the angle $ACB = \phi$; and consequently

$$\text{(i)}\quad \sin \Upsilon B = \sin \alpha_r \;= \sin \lambda \cos \omega / \cos \delta$$

$$\text{(ii)}\quad \sin AB = \sin \Delta \gamma \;= \tan \phi \tan \delta$$

$$\text{(iii)}\quad \Upsilon A = \alpha_0 \;= \alpha_r \mp \Delta \alpha$$

where α_r denotes right ascension, α_0 oblique ascension, and $\Delta \alpha$ ascensional difference.

To calculate the time of rising of any particular sign we have

$$\text{(iv)}\quad t_n = \alpha_{r(n)} - (\Delta \alpha_n - \Delta \alpha_{n-1})$$

where t_n is expressed in degrees, and n refers to the n^{th} sign according to the order given in tables 6 and 7.

The *Pauliśa Siddhānta* gives the ascensional differences in the form $20e$, $16\frac{1}{2}e$, $6e$ where e is the equinoctial noonday shadow. Brahmagupta similarly gives $19e$, $16\frac{1}{4}e$, $6e$. The only table of oblique ascensions appears to be the very rough one in Varāha Mihira's *Bṛihaj Jātaka*; the later *Sūrya Siddhānta* gives right ascensions, but none of the early Hindu texts appears to give correct tables for oblique ascensions or ascensional differences. The fairly accurate tables given in tables 6 and 7 are taken from Abū 'Ali al-Marrākoshī (13th century).

8. **The lagna.**—The point of the ecliptic on the horizon (horoscope, ascendens) at any time is termed the *lagna*. Its determination may be explained by an example. Suppose that 7 hours 17 minutes has elapsed since sunrise at a place whose latitude is 36°N., and that the longitude of the sun is 42 degrees. The table of oblique ascensions (table 7), converted into time units, gives for latitude 36°

$$t_1 = 1^h\,17^m,\; t_2 = 1^h\,31^m,\; t_3 = 1^h\,57^m,\; t_4 = 2^h\,21^m,$$
$$t_5 = 2^h\,28^m.$$

Since the sun has advanced 12 degrees into the second sign we have first to find how much of t_2 has not been used up. This is

$$(1^h\,31^m) \times (30^\circ - 12^\circ) / 30^\circ = 55 \text{ minutes approximately.}$$

Now

$$7^h\,17^m = 55^m + 1^h\,57^m + 2^h\,21^m + (2^h\,4^m),$$

the last term being less than t_5. The time then corresponds to some point in t_5 (Leo); and since

$$x / 30 = (2^h\,4^m) / (2^h\,28^m)$$

gives $x = 25^\circ\,8'$ the longitude of the *lagna* is approximately 4 signs 25 degrees 8 minutes.*

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* Theon (c. A.D. 380) calculated the *lagna* or 'horoscope' in the same way, but with reference to *temporary hours*. Apparently the Hindus did

9. **Length of day.**—The difference between the length of the day and night is equivalent to twice the angle GCF in figure 1, when FGR represents the path of the sun. Now sin GCF or sin $\Delta\alpha$ has been shown (§ 5(a) v) to be equal to tan ϕ tan δ. The length of the day in hours is therefore $(180° + 2\ \Delta\alpha)/15$ and in ghaṭis it is $(180° + 2\ \Delta\alpha)/6$ where $\sin \Delta\alpha = \tan\phi \tan\delta$, and for the longest day $\sin\Delta\alpha = \tan\phi\tan\omega$.[*] This rule is given by Pauliśa (*PS.* iii, 11) and Brahmagupta, and Āryabhaṭa (*G* 19) notes the connexion with the 'six hour circle.'[†]

No tables of the lengths of days are given in the early Hindu texts: the following is taken from Abū 'Alī al-Marrākoshī.

Longest days for different latitudes.

Latitude.	3°	6°	9°	12°	15°	18°	21°	24°	27°	30°	33°	36°	39°	42°	45°	48°	51°	54°	57°	60°	63°	66°
Hours ..	12	12	12	12	12	13	13	13	13	13	14	14	14	15	15	15	16	16	17	18	19	22
Minutes ..	10	21	31	42	53	5	17	29	42	56	11	28	45	5	27	51	21	55	37	33	52	28
Seconds ..	34	12	44	40	44	20	4	52	56	58	52	8	54	4	12	28	4	4	44	4	0	32

The planets.

10. All the planets, including the sun and moon, are supposed to have the same absolute daily motion of about 12,000 yojanas. The orbit of the moon being known, the orbits of the other planets are found by (*orbit of moon*) × R_m / R_p, where R_m and R_p are the revolutions in a cycle of the moon and the planet respectively. Whether the elements for the moon were obtained from parallax observations or not is uncertain, but there is no direct evidence of such observations. The following table is based on the elements of the later *Sūrya Siddhānta* :—

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not at any time employ 'temporary' *muhūrtas* or *ghaṭis*, but see *Albīrūnī* (*India* i, 338), who discusses this interesting topic.

[*] In modern notation $\cos h = -\tan\phi\ \tan\delta$ where $2h/15$ is the length of the day in hours.

[†] The *Jyotisha Vedāṅga* rule is :—

$$\textit{length of day} = 12 \pm 2\,(183 - n)\,/\,61 \text{ muhūrtas}$$

where n is the number of days counting from a solstice. The longest day is therefore 18 muhūrtas = 14 hours 24 minutes, the shortest day is 12 muhūrtas = $9^h\ 36^m$ and the daily increase is $2/61$ muhūrtas = $1^m\ 34^s$. The *Paitāmaha Siddhānta* gives 1591 palas (= $10^h\ 36^m\ 24^s$) for the shortest day and 3 palas for the daily increase.

	A ORBITS.	B SIDEREAL PERIODS.	A ÷ B MEAN DAILY MOTION.
	Yojanas.	Days.	Yojanas.
MOON*	324,000	27·321674	11,858·7
MERCURY	1,043,209	87·969702	11,858·7
VENUS	2,664,637	224·608568	11,858·7
SUN	4,331,500	365·258756	11,858·7
MARS	8,146,909	686·997494	11,858·7
JUPITER	51,375,764	4,332·320652	11,858·7
SATURN	127,668,255	10,765·773075	11,858·7

The diameters of the planets other than the sun and moon are generally given in terms of that of the moon. There is little agreement as to the values, some of which are shown in table 4.

11. **Mean motions.**—The mean motions of the planets are shown in the form of the number of revolutions in a yuga or cycle. For example,† Āryabhaṭa gives the sidereal revolutions in 4,320,000 years as

SUN	4,320,000	MERCURY ..	17,937,920
MOON	57,753,339	JUPITER ..	364,224
MARS	2,296,824	VENUS ..	7;022,388
SATURN	146,564		

Since at the beginning of the Kaliyuga (i.e. sunrise at Ujjain, 18th February, 3102 B.C.), or at the beginning of the Kalpa, all the planets were supposed to be in conjunction, the finding of the mean place at any particular time is not a difficult matter. If t be the time elapsed from the epoch, then having reduced t to sāvana days, d. (i.e. having calculated the *ahargaṇa*) the position is obtained by dR / Y. ‡

There is no indication as to the means by which the revolutions (R) given were obtained. They first appear in the texts in a fairly accurate form and their appearance coincides with the introduction of the larger cycles—which, indeed, were introduced in order to express the planetary revolutions in integral quantities.

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* The early Hindu astronomers were, of course, well aware of the natural order of the planets, but usually they place them in the 'week-day order.'

† For other values see table 2.

‡ $\frac{Y}{R}$ is the period (P) of the planet, but the Hindus did not generally utilise this ratio as a single element—See, however, the *Pañchasiddhāntikā*, Ch. XVI.

12. **Synodic revolutions.**—The synodic revolutions are not usually given in the texts, but they occur in a somewhat disguised form in the *Pañchasiddhāntikā* (Ch. xviii). If P_c is the synodic period of a planet and P_* is its sidereal period and E is the sidereal year we have

$$\frac{1}{E} = \frac{1}{P_c} \pm \frac{1}{P_*}$$

where the upper sign is to be taken for a superior and the lower for an inferior planet; and since $P_* = YE/R$ we have $P_c = YE/\pm(Y-R)$ which is the rule implied by Varāha Mihira. His synodic revolutions are given in *saura* days as follows:—

Mars.	Mercury.	Jupiter.	Venus.	Saturn.	
$768\frac{3}{4}$	$114\frac{6}{29}$	$393\frac{1}{7}$	$575\frac{1}{2}$	$372\frac{2}{3}$	saura days.

and since 360 saura days = 365·256 mean solar days approximately these values become

Mars.	Mercury.	Jupiter.	Venus.	Saturn.	
780	115·9	398·8	583·9	378	days.

13. **Epicycles.**—The calculated mean positions of the planets were corrected for the so-called 'first inequality' (that one, namely, which depends on the planet's position relative to the sun), in the Greek fashion, by assuming certain epicyclic motions. The Greek astronomers taught that, while the planet's mean motion could be represented as a movement on the circumference of one circle, called the *deferent*, its actual motion was on the circumference of another circle, called the *epicycle*, whose centre was the mean position on the circumference of the deferent. This is the scheme in broad outline only: it was apparently based on the principle that the motions of a heavenly body must be made up of pure circular motions —a principle that does not appear to have influenced the Hindus.

In figure 10 the epicyclic motion of an outer planet of the type of Mars is roughly represented. The point E represents the position of the earth, the circle $A_0\, A_1\, A_2$, etc., is the deferent, and the circle $b_1\, B_1$ is the epicycle when the mean position of the planet is at A_1. The epicycle is not drawn for other mean positions, but its radius is marked ($A_2\, B_2$, $A_3\, B_3$, etc.). The points A_0, A_1, A_2, etc., mark the mean position on the deferent at intervals of 30 degrees, the corresponding positions on the epicycle being B_0, B_1, B_2, etc. The period of revolution of A on the deferent is the sidereal period (P_*) of the planet, and the period of revolution of B on the circumference of the epicycle is the sidereal year (E). At $EA_0\,B_0$ the earth, sun and planet are in line: the point B moves from B_0 to B_1 while the point A moves from A_0 to A_1 and we have

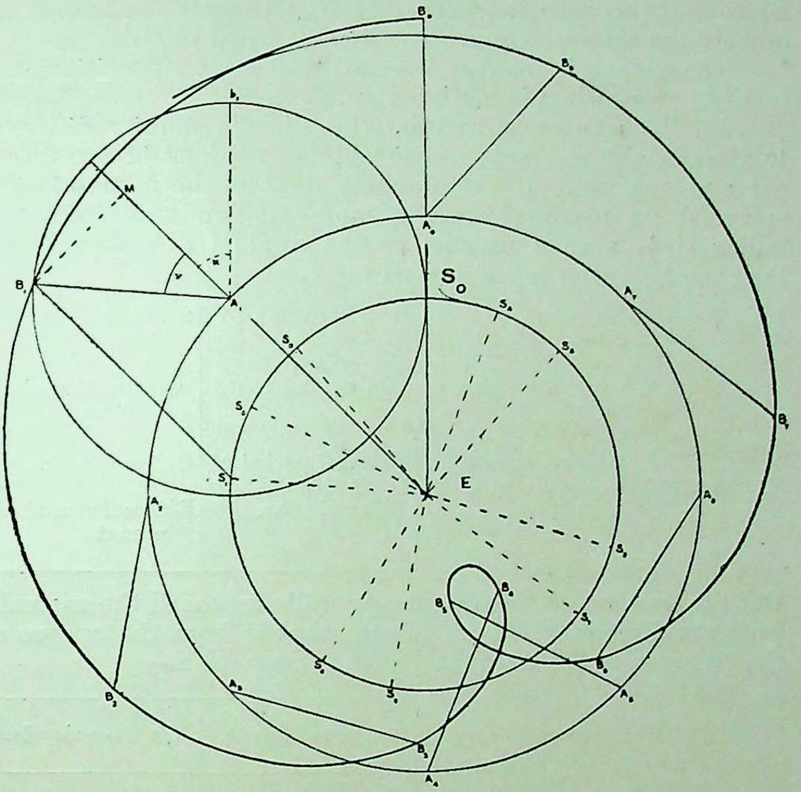

Fig. 10.

$$\frac{\text{angle } B_1\,A_1\,b_1}{\text{angle } A_1\,E\,A_0} = \frac{1\,/\,E}{1\,/\,P_*} = 1{\cdot}8 \text{ in the figure.}$$

From B_4 to B_5 the planet retrogrades and the angle of retrogression E is in the figure approximately 25 degrees. The stationary points are determined by

$$B\pi\,/\,EB = (\textit{velocity in deferent})\,/\,(\textit{velocity in epicycle}) = u\,/\,v.^*$$

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* See § 20(a).

If $S_0 S_1 S_2$, etc., represents the orbit of the sun, then $B_0 S_0$, $B_1 S_1$, $B_2 S_2$, etc., represent the distance of the planet from the sun, and, since ES is, with the superior planets,* always parallel to AB (because the period of B is the same as that of S, namely the sidereal year), BS is always equal to EA.

The planet is nearest the earth when in opposition and furthest away when in conjunction.

14. The superior and inferior planets require different treatment with reference to the relative motions in the deferent and epicycle. If the anomaly (that is the motion in the epicycle) be reckoned in the more modern way from the radius $A_1 b_1$ always parallel to the original direction $A_0 B_0$, then the following scheme holds † :—

PERIODS OF REVOLUTION.

		On the deferent.	On the epicycle.
MODERN WAY	Superior planets	Sidereal period of planet.	Sidereal year.
	Inferior ,,	Sidereal year.	Sidereal period of planet.

But the Greeks and the Hindus generally reckoned the anomaly from the directions EA_0, EA_1, etc., that is from the apogee of the epicycle, and consequently the periods were—

		On the deferent.	On the epicycle.
ANCIENT WAY	Superior planets	Sidereal period of planet.	Synodic period of planet.
	Inferior ,,	Sidereal year.	Synodic period of planet.

15. **The Hindu scheme.**—The general explanation of the disturbing curses of the planetary motions is, in the words of the Sūrya Siddhānta (ii, 1–4), as follows :—

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* For Mercury and Venus the centre of the epicycle is on the line pointing to the mean place of the sun, since in these cases the period of A is the same as that of S.

† In fig. 10 what may be termed the 'modern anomaly' is $v + u$, while the 'ancient anomaly' is v; and, since for a superior planet

$$1/E = 1/P_* + 1/P_c \text{ or } (P_c + P_*)/P_c = P_*/E;$$

and also $(u + v)/u = P_*/E$, we have $v/u = P_*/P_c$. Similarly for an inner planet, as

$$\frac{1}{E} = \frac{1}{P_*} - \frac{1}{P_c} \text{ and } \frac{u+v}{u} = \frac{E}{P_*} \text{ we have } \frac{v}{u} = \frac{E}{P_c}.$$

> "Forms of time. of invisible shape, stationed in the zodiac, called *śīgrochcha*. *mandochcha*, and *pāta*, are causes of the motions of the planets. The planets attached to these beings by. cords of air are drawn away by them with the right hand and left hand, forward and backward according to nearness towards their own place. A wind, moreover, called *pravaha*, impels them towards their own points; being drawn away forward or backward they proceed by a varying motion. The so-called *uchcha*, when in the half orbit in front of the planet, draws the planet forward: in like manner, when in the half orbit being the planet, it draws it backward."

The term *mandochcha*, or 'apex of slowest motion,' corresponds to the term *aphelion*, while the term *śīghrochcha*, or 'apex of swiftest motion,' corresponds to the term *conjunction*.* In the earlier siddhāntas the line of apsides appears to have been considered as fixed, but later a definite motion was given —possibly on the analogy of the motion of the moon's line of apsides; but on what principle the actual values given were obtained is not indicated. For the positions of apogee or aphelion the following longitudes are given †:—

	Sun.	Mars.	Mercury.	Jupiter.	Venus.	Saturn
Pañchasiddhāntika ..	..	110°	220°	160°	80°	240°
Brāhmasphuṭasiddhānta	..	127°	227°	170°	90°	252°
Sūrya Siddhānta ..	77°	130°	220°	171°	80°	237°

and the following are the revolutions given to the lines of apsides in 4,320,000,000 years:—

	Sun.	Moon.	Mars.	Mercury.	Jupiter.	Venus.	Saturn
Brahmagupta	480	488,105,858	292	382	855	653	41
Sūrya Siddhānta	387	488,203,000	204	368	900	535	39

For Saturn the motion of aphelion amounts to about one minute of arc in five thousand years!

The Pañchasiddhāntikā says—"The Sun is the so-called *śīghra*," and in the Hindu system, as in the Greek, the revolution of the conjunction of an inferior planet takes the place of the actual revolution of the planet itself.‡

16. **The two epicycles.**—The Hindu scheme differs considerably in detail from that of Ptolemy. The object appears to have been the attainment of the correct apparent position of the planet without reference to the representation of its

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* 'Superior conjunction' is meant.

† Āryabhaṭa gives 78° for the apogee of the sun. Barth, assuming that this was the result of direct observation, attempted to estimate therefrom the date of Āryabhaṭa's astronomy.

‡ A revolution was considered complete only when the planet had passed through the whole zodiac: this Venus and Mercury are only able to accomplish as they accompany the sun in its apparent annual motion.

actual motion. As far as information is available we gather that the planet was regarded as actually moving in the deferent, and that the system of epicycles was solely for the purpose of ascertaining the apparent position in the deferent at any time.

The Hindu system involves the use of two different and independent epicycles for each planet (except the sun and moon) and four sets of calculations, and the epicycles, at least in the later works, vary in dimensions with reference to their positions on the deferent. In the *Sūrya Siddhānta* these epicycles are termed *manda paridhi*, or 'epicycle of the apsis,' and *śīghra paridhi*, or 'epicycle of conjunction' and their dimensions as given in that work are as follows * :—

DIMENSIONS OF EPICYCLES.

	Circumference of *manda paridhi* = E_a.		Circumference of *śīghra paridhi* = E_c.	
	Anomaly 0° or 180″.	Anomaly 90° or 270″.	Anomaly 0° or 180″.	Anomaly 90° or 270″.
SUN	14° 0′	13° 40′	....	....
MOON	32° 0′	31° 40′	....	....
MARS	75° 0′	72° 0′	235° 0′	232° 0′
MERCURY ..	30° 0′	28° 0′	133° 0′	132° 0′
JUPITER ..	33° 0′	32° 0′	70° 0′	72° 0′
VENUS	12° 0′	11° 0′	262° 0′	260° 0′
SATURN ..	49° 0′	48° 0′	39° 0′	40° 0′

The change in the dimension of the epicycle is proportional to the sine of the anomaly. If ΔE is the difference as given in the table and θ the anomaly then the dimension at θ is given by $E - \Delta E \,.\, \sin\theta$, or, if the Hindu sine function is used, by $E - \Delta E \,.\, \sin\theta / r$. This result is based upon the proportion

$$\frac{x}{\Delta E} = \frac{\sin\theta}{\sin 90^\circ}$$

where x is the diminution at θ. If

$$e \,.\, 360^\circ = E - \Delta E \sin\theta, \text{ or } E - \frac{\Delta E}{r} \sin\theta$$

we may term 'e' the reduced epicycle.

---

* Brahmagupta gives: Sun 14° to 13° 40′; Moon 36° 31′ to 30° 44′.

But E and $e360°$ are only apparent dimensions, and the change is probably due to a supposed change in the distance from the centre of the deferent to the centre of the epicycle, and is connected with the 'second inequality'—due to the excentricity of the orbits.*

The values of E are for the circumference of the epicycle in terms of the circumference of the deferent. For example the value 72 for Mars means that

$$\frac{\text{the circumference of epicycle}}{\text{the circumference of deferent}} = \frac{72}{360} = \frac{1}{5}$$

or $r_e / r_d = 1/5$ where r_e is the radius of the epicycle and r_d is the radius of the deferent. We shall denote r_e / r_d by e_a or e_c according as the epicycle of the apsis or the epicycle of conjunction is employed.

17. **The equation of the centre.**—The processes involved in determining the equation of the centre are generally four. If λ denotes the mean position of the planet then the first correction gives $\lambda_1 = \lambda + \epsilon_1 / 2$ where ϵ_1 is the equation arrived at by employing the epicycle of conjunction; the second correction gives $\lambda_2 = \lambda_1 + \epsilon_2 / 2$ where ϵ_2 is the equation derived by employing the epicycle of the apsis; $\lambda_3 = \lambda + \epsilon_3$ where again the epicycle of the apsis is employed; and finally $\lambda_4 = \lambda_3 + \epsilon_4$ where the epicycle of conjunction is again employed.

The calculations may be summarised thus :—

$$\text{(i)}\quad \lambda_1 = \lambda + \epsilon_1 / 2 \quad \text{where} \quad \sin \epsilon_1 = \frac{e_c \, . \sin v_0}{\sqrt{e_c^2 + 2e_c \, . \cos v_0 + 1}}$$

$$\text{(ii)}\quad \lambda_2 = \lambda_1 + \epsilon_2 / 2 \quad ,, \quad \sin \epsilon_2 = e_a \, . \sin v_1'$$

$$\text{(iii)}\quad \lambda_3 = \lambda + \epsilon_3 \quad ,, \quad \sin \epsilon_3 = e_a \, . \sin v_2'$$

$$\text{(iv)}\quad \lambda_4 = \lambda_3 + \epsilon_4 \quad ,, \quad \sin \epsilon_4 = \frac{e_c \, . \sin v_3}{\sqrt{e_c^2 + 2e_c \, . \cos v_3 + 1}}$$

where $v_0 = \lambda_c - \lambda$; $v_3 = \lambda_c - \lambda_3$; $v_1' = \lambda_a - \lambda_1$;

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* The term 'oval' has been applied to the epicycle in this connexion but is not altogether appropriate.

Theoretically, at least, the origin of the change in dimension of the epicycle is known. In the case of the moon the effect of the second inequality was always to increase the absolute value of the first one, particularly in the quadratures. "The obvious inference was," writes J. L. E. Dreyer (*Planetary Systems*, p. 193), "that the radius of the epicycle appeared to be of variable length, greater in quadrature than in syzygy." But Ptolemy made the centre of the epicycle move on an excentric so that its distance from the earth varied and consequently so did the apparent dimensions of the epicycle. The excentric appears comparatively late in India. See the *Siddhānta S'iromaṇi*, G. v, 7*f*.

and $v_2' = \lambda_a - \lambda_2$; and consequently

$$v_3 = v_0 - \epsilon_3 \text{ and } v_2' = v_1' - \epsilon_2/2.$$

The calculations according to the *Pañchasiddhāntikā* (ch. xvii) may be expressed in the following form. The later texts give rather more complicated but not essentially different rules, of which a specimen will be exhibited in due course.

i.	ii.	iii.	iv.
$a_1 = e_c \sin v$	$a_2 = e_a \sin v_1'$	$a_3 = e_a \sin v_2'$	$a_4 = e_c \sin v_3$
$b_1 = e_c \cos v$	....	....	$b_4 = e_c \cos v_3$
$c_1 = \sqrt{a_1^2 + (r_d + b_1)^2}$	....	....	$c_4 = \sqrt{a_4^2 + (r_d + b_4)^2}$
$\epsilon_1 = \sin^{-1} a_1 r_d / c_1$	$\epsilon_2 = \sin^{-1} a_2$	$\epsilon_3 = \sin^{-1} a_3$	$\epsilon_4 = \sin^{-1} a_4 r_d / c_4$
$\lambda_1 = \lambda + \epsilon_1/2$	$\lambda_2 = \lambda_1 + \epsilon_2/2$	$\lambda_3 = \lambda + \epsilon_3$	$\lambda_4 = \lambda_3 + \epsilon_4$

18. The Hindu method as applied to a superior planet is illustrated in figure 10. The period of the epicycle is the synodic period of the planet (reckoning in the Greek fashion always from EA) and that of the deferent is the sidereal period of the planet. We have

$$A_0 EA_1 / M A_1 B_1 = P_c / P_* \text{ or } \frac{u}{v} = \frac{P_c}{P_*}.$$

The problem is to calculate $\epsilon = B_1 E A_1$. The line $B_1 M = a$ is perpendicular to EA_1 while $A_1 M = b$. Now $EM^2 + a^2 = EB_1^2$

or $$(r_d + b)^2 + a^2 = EB_1^2 \text{ and } \frac{a}{EB_1} = \sin \epsilon;$$

but $b = r_e \cdot \cos v$ and $a = r_e \cdot \sin v$, therefore

$$\text{(i)} \quad \sin \epsilon = \frac{r_e \cdot \sin v}{\sqrt{(r_d + r_e \cdot \cos v)^2 + r_e^2 \cdot \sin^2 v}}$$

$$= \frac{e \cdot \sin v}{\sqrt{1 + e^2 + 2e \cdot \cos v}} \text{ where } e = \frac{r_e}{r_d}.$$

A simpler formula is

$$\text{(ii)} \quad \tan \epsilon = \frac{B_1 M}{EM} = \frac{r_e \cdot \sin v}{r_d + r_e \cos v}$$

$$= \frac{e \cdot \sin v}{1 + e \cdot \cos v} \text{ or } \frac{\sin v}{1/e + \cos v},$$

but the Hindus, like the Greeks, did not employ the tangent function.

The maximum value of ϵ occurs when EB is a tangent to the epicycle, that is when AB is at right angles to EB; and then $\sin \epsilon = r_e / r_d = e$, and $v = 90° + \epsilon$.*

19. The following calculation for the equation of the centre of Venus is based upon the later *Sūrya Siddhānta* elements † :—

The equation of the centre for Venus.

Given mean longitude ..	$8^s\ 18°\ 13'$.
Longitude of conjunction..	$10^s\ 21°\ 50'$: anomaly $v = 2^s\ \ 3°\ 37'$.
Longitude of apsis ..	$2^s\ 19°\ 52'$: anomaly $v' = 5^s\ 18°\ 35'$.
Epicycle of conjunction ..	E_c varies from 260° to 262°. Difference $\Delta E_c = 2°$. Reduced epicycle $e_c = (rE_c - \Delta E_c \sin v) / 360\, r$.
Epicycle of apsis ..	E_a varies from 11° to 12°. Difference $\Delta E_a = 1°$. Reduced epicycle $e_a = (rE_a - \Delta E_a \sin v') / 360\, r$.

	i. For equation of conjunction.	ii. For equation of apsis.	iii. For equation of apsis.	iv. For equation of conjunction.
Longitude ..	$\lambda = 8^s\ 18°\ 13'$	$\lambda_1 = 9^s\ \ 1°\ 17'$	$\lambda_2 = 9^s\ \ 1°\ 28'$	$\lambda_3 = 8^s\ 18°\ 36'$
Anomaly ..	$v = 2^s\ \ 3°\ 37'$	$v_1' = 5^s\ 18°\ 35'$	$v_2' = 5^s\ 18°\ 24'$	$v_3 = 2^s\ \ 3°\ 14'$
sin v	$\sin v = 3080'$	$\sin v_1' = 689'$	$\sin v_2' = 691'$	$\sin v_3 = 3069'$
cos v	$\cos v = 1527'$	$\cos v_1' = 3369'$	$\cos v_2' = 3368'$	$\cos v_3 = 1548'$
Corrected epicycle e	$e_c = {\cdot}723$	$e_a = {\cdot}0328$	$e_a = {\cdot}0328$	$e_c = {\cdot}723$
$a = e \sin v$ ..	$a_1 = 2226'$	$a_2 = 22{\cdot}3'$	$a_3 = 22{\cdot}6'$	$a_4 = 2218'$
$b = e \cos v$ ..	$b_1 = 1104'$	$b_2 = 110'$	$b_3 = 110{\cdot}4'$	$b_4 = 1119'$
$c = \sqrt{a^2 + (r + b)^2}$	$c_1 = 5058'$	$c_2 = 3548'$	$c_3 = 3458'$	$c_4 = 5067'$
$\sin^{-1} ar / c = \epsilon$ ..	$\epsilon_1 = 26°\ 7'$	$\epsilon_2 = 0°\ 22'$	$\epsilon_3 = 0°\ 23'$	$\epsilon_4 = 25°\ 59'$
Corrected longitude	$\lambda + \frac{\epsilon_1}{2} = 9^s\ 1°\ 17'$	$\lambda_1 + \frac{\epsilon_2}{2} = 9^s\ 1°\ 28'$	$\lambda + \epsilon_3 = 8^s\ 18°\ 36'$	$\lambda_3 + \epsilon_4 = 9^s\ 14°\ 35'$

The process, it will be seen, is the same as that of the Pañchasiddhāntikā except that variable epicycles have been introduced.

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* Since $v = 90 + \epsilon$ we have

$$\tan \epsilon = \frac{e \cos \epsilon}{1 - e \sin \epsilon} \text{ or } \sin \epsilon = e\,(1 - \sin^2 \epsilon) \,/\, (1 - e \sin \epsilon)$$

of which a solution is $\sin \epsilon = e$.

† See *J.A.O.S.*, 1858, 213*f*.

20. The only process required in the cases of the sun and moon is the 'correction for the apsis,' which may be represented by $\tan \epsilon = (e \sin v) / (1 + e \cos v)$. The early texts give tabular results by means of which the calculations may, to some extent, be avoided. These, however, are not very complete and are not altogether in agreement.*

20 (*a*) *Retrogression.*—In figure 10 (*a*) if $B\beta$ or $B'\beta'$ ($= r \,.\, \Delta v$ or $r \,.\, \Delta v'$) is the arc on the epicycle passed over in time Δt, r being the radius of the epicycle, and $v = CAB$ or CAB' being the anomaly, then if $B\beta$ is small, the angle $B\beta\eta = ABB'$ and $\beta\eta = B\beta \cos ABB'$. But $\beta\eta / EB = \alpha\alpha' / R$ where R is the radius of the deferent, therefore

$$\alpha\alpha' = R \,.\, \beta\eta / EB = R \,.\, \frac{B\beta}{EB} \cos ABB'$$

$$= \frac{R \,.\, r.\Delta v \,.\, B\pi}{rEB} = \frac{B\pi}{EB} \,.\, R.\Delta v \quad \text{or} \quad \frac{B\pi}{EB'} R.\Delta v.$$

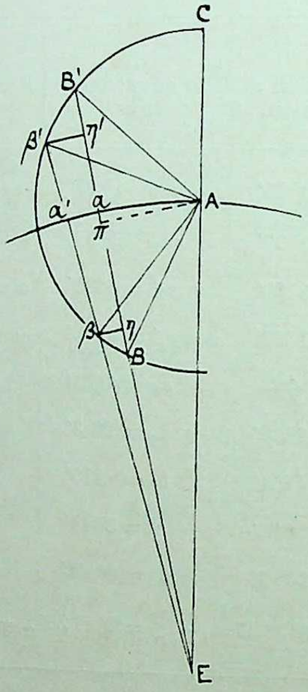

Fig. 10 (a)

If $\alpha'\alpha$ is equal and opposite to the motion in the deferent, that is if

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[*] According to Jacobi and Sewell (*Epigraphia Indica*, i, 441 and xiv, 10) $\sin \epsilon = e \sin v$ where e is the 'reduced epicycle' (§ 16) is generally employed.

$$R \,.\, \Delta u - \frac{B\pi}{EB} \,.\, R.\Delta v = 0, \text{ then } \frac{B\pi}{EB} = \frac{\Delta u}{\Delta v}$$

and B is a 'station' of the planet and $2AEB$ is the angle of retrogression Instead of $B\pi$ the *Sūrya Siddhānta* gives 'the difference between the hypotenuse and the radius,' that is $R - EB$ or $EB' - R$.

The text then gives the angles ABE for the stationary points B as follows:—

Mars.	Mercury.	Jupiter.	Venus.	Saturn.
16	36	50	17	65

from which the angles of retrogression AEB may easily be calculated if r/R be known. The Hindu texts do not give this value definitely, but it is approximately e, calculated for the epicycle of 'conjunction.'

21. **Latitude.**—The node, Rāhu, is said to cause the deviation of the planets in latitude (SS. ii, 6). The later rule for latitude given is

$$\beta = \frac{\beta' \sin \Delta\lambda}{r/r'}$$

where β' is the maximum deviation as seen from the earth at its mean distance, r is the true distance of the planet from the earth, and r' is its mean distance, and $\Delta\lambda$ is the distance of the planet from its node. The deviations are given as follows:—

	Moon.	Mars.	Mercury.	Jupiter.	Venus.	Saturn.
Pañchasiddhāntikā	4° 0′	1° 41′	2° 15′	1° 41′	2° 15′	2° 15′
Sūrya Siddhānta . .	4° 30′	1° 30′	2° 0′	1° 0′	2° 0′	2° 0′

Parallax.

22. In works of the earlier period there is no reference to parallax and there is no real attempt to measure the distances of the sun, moon and other planets; while in later works the subject of parallax occurs only in connexion with eclipses. The later *Sūrya Siddhānta* treats of parallax in longitude (*harija*, Gk. ὁριζων), and parallax in latitude (*avanati*, 'depression'): it states that there is no solar parallax in latitude when the ecliptic is a vertical circle, and also that there is no parallax of the sun in longitude when that planet is in the meridian. This latter statement is not true, as Whitney points out,* unless the ecliptic is also bisected by the meridian. (See § 6(*g*)).

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* *J.A.O.S.*—1858, p. 286.

The horizontal parallax of the sun or moon is assumed to be equal to the motion of the planet during four *nāḍikās*, or one-fifteenth part of a day. We thus have

$\pi = (\textit{daily motion of sun}) / 15 = \theta_s / 15$ for the horizontal parallax of the sun,

$\pi' = (\textit{daily motion of moon}) / 15 = \theta_m / 15$ for the horizontal parallax of the moon,

where θ is the angular motion of the planet during the day.* Since $\theta = s / r$ nearly, where r is the radius of the orbit and s is the arc traversed in one day, and since, in the Indian system, s is *constant for all planets* and is equal to 12000 yojanas,† we have $s / 15 = 800$ yojanas, which is the Hindu value of the earth's radius; and π becomes equal to $s / 15r = \rho / r$ ‡ which is approximately true when r is great compared with ρ.

Sometimes the difference between the parallax of the sun and moon is given. Thus the parallax in latitude is given in forms that may be expressed by

$$\pi_\beta' - \pi_\beta = (\theta_m - \theta_s)(\sin z_e) / 15 = 49' (\sin z_e) / r$$
$$= (\sin z_e) / 70$$

where $\sin z_e$ is the *dṛikshepa* (see § 6(g)).

The rule for parallax in longitude may be expressed by

$$\pi_\lambda = \pi \cos z_e \sin (\lambda_\gamma - \lambda)$$

where λ is the longitude of the star and λ_γ is the longitude of the nonagesimal.§

The Hindu rules for parallax may then be summarised thus:

(i) Horizontal parallax $\pi = \theta / 15$

(ii) Parallax in latitude $\pi_\beta = \pi \sin z_e$

(iii) Parallax in longitude $\pi_\lambda = \pi \cos z_e \sin \lambda_\gamma - \lambda$

while the corresponding approximately correct formulae are

(i) $\sin \pi = \rho / r$

(ii) $\pi_\beta = \pi \sin \beta_z \sin (\gamma - \beta) / \sin \gamma$

(iii) $\pi_\lambda = \pi \cos \beta_z \sin (\lambda_z - \lambda) / \cos \beta$

---

* The mean values of the daily motion usually given are: moon 13° 10′ 34″; sun 59′ 8″, which make $\pi' = 52{\cdot}7$ and $\pi = 3{\cdot}9$; but the texts give no actual parallax values explicitly. The *Sūrya Siddhānta* implies $\pi' = 53{\cdot}3'$ and $\pi' - \pi = 49'$.

† The *Sūrya Siddhānta* value is 11,858·7 yojanas.

‡ $\text{Sin}\ \pi = \rho \ r$.

§ In the texts the meridian ecliptic point is sometimes substituted for the nonagesimal point.

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where λ and β are the stars, geocentric longitude and latitude, and λ_z and β_z are the longitude and latitude of the zenith, and

$$\tan\gamma = \tan\beta_z / \cos(\lambda_z - \lambda).$$

We then have

$$\text{(i)}\quad \theta / 15 = \rho / r \text{ nearly;}$$

$$\text{(ii)}\quad \pi \sin z_e = \pi \sin\beta_z \sin(\gamma - \beta) / \sin\gamma;$$

and $\text{(iii)}\quad \pi \cos z_e \sin(\lambda_\gamma - \lambda') = \pi \cos\beta_z \sin(\lambda_z - \lambda) / \cos\beta;$

and as β is generally considered negligible in these Hindu calculations we have

$$z_e = \beta_z \text{ and } \sin(\lambda_\gamma - \lambda') = \sin(\lambda_z - \lambda)$$

where λ' is the apparent longitude; and as a matter of fact the zenith distance (z_e) of the nonagesimal is equal to the latitude of the zenith (β_z), and the longitudes of the zenith (λ_z) and the nonagesimal (λ_γ) are the same.

Lunar eclipses.

23. **Diameter of the shadow.**—In figure 11 we have

$$\text{(i) the angle } TEM = PTE - POE = PTE - Q'ES$$
$$= PTE - (QES - QEQ')$$

where S, E, and M are the centres of the sun, earth and moon respectively, EP and SQ are perpendiculars to OPQ, TM is

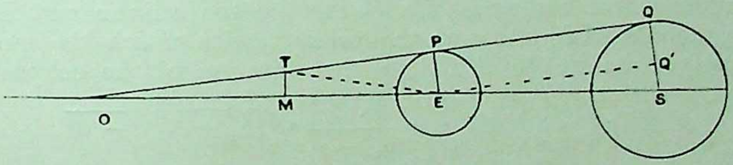

Fig. 11.

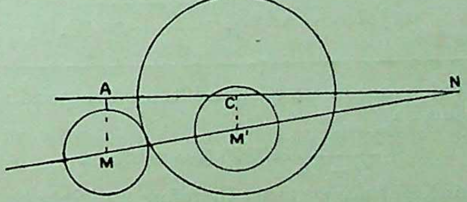

Fig. 12.

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perpendicular to OS, and EQ' is parallel to PQ. If R_c, R_m, R_e, R_s denote the radii of the shadow, the moon, the earth and the sun respectively, and if r_m and r_s denote the distances of the centres of the moon and sun from the centre of the earth, then, since the angles are all small, we obtain from (i)

$$\text{(ii)}\ R_c = R_e - R_e\,(R_s\,/\,R_e - 1)\ r_m\,/\,r_s.$$

The *Pauliśa Siddhānta* simply assumes that $R_c = 38'$; the old *Sūrya Siddhānta* gives the rule in the form

$$2R_c = 36' - 36'\ \frac{r_m}{r_s}\Big/\frac{90}{276}$$

which * is obtained from (ii) by making

$$R_e = 18' \text{ and } R_s = 73{\cdot}2';$$

while the modern *Sūrya Siddhānta* gives it thus—

$$R_c = R_e\,m_m + R_e\,m_s\,(R_m\,/\,R_s) - R_s\,m_s\,(R_m\,/\,R_s)$$

where m_m and m_s are the ratios of the true daily motions to the mean daily motions of the moon and sun respectively. This rule implies two assumptions, neither of which is strictly accurate: (*a*) that the ratio of the true daily motion to the mean daily motion is equal to the ratio of the mean distance to the true distance; (*b*) that $R_m\,/\,R_e = r_m\,/\,r_s$, which implies that the mean apparent values of the diameters of the sun and moon are equal.

24. **Duration.**—In figure 12 let M be the centre of the moon when about to enter the shadow, C the centre of the shadow whose radius is R_c; let AN be the ecliptic and MN the moon's path. If v is the velocity with which the moon travels from M to M' then the duration of the eclipse is

$$\text{(iii)}\ t = 2MM'\,/\,v = \frac{2\,.\,60^n}{\theta_m - \theta_s}\sqrt{(R_c \pm R_m)^2 - \beta^2}$$

where β is the moon's latitude at the time of opposition, and since there are 60 nāḍikās in a day.

For the time between the first and last moments of internal contact we have

$$\text{(iv)}\ t = \frac{2}{v}\sqrt{(R_c - R_m)^2 - \beta^2}.\ \dagger$$

---

* Here the values are in lengths and the corresponding value of the moon's orbit would be

$$\frac{324000}{800 \div 18} = 7290 \text{ (see table 4).}$$

To reduce to minutes of arc we must therefore multiply by $360 \times 60 \div 7290$.

† The time rules (iii) and (iv) may be obtained direct from the modern rule

$$a = \sqrt{(\beta - bt)^2 + (m - s)^2\,t^2},$$

where b is the rate of the moon's motion in latitude, and m and s are the

The *Pauliśa Siddhānta* gives rule (iv) in the form

$$t = \frac{2}{v} \cdot \frac{21}{5} \sqrt{4(5 - \Delta\lambda)(10 - (5 - \Delta\lambda))}.$$

Since
$$\beta / 240' = \sin \Delta\lambda / \sin 90°,$$

where 240′ is the moon's greatest latitude, and $\Delta\lambda$ is the difference in longitude between the moon and its node; and since

$$\sin \Delta\lambda / \sin 10° = \Delta\lambda / 10,$$

nearly, where 10° is the limit from the node for a total eclipse; we have

$$\beta = 240' \times 21 \times \Delta\lambda / 10 \times 120 = 21 \Delta\lambda / 5,$$

where 21′ is the sine of 10 degrees and 120′ is the sine of 90 degrees according to the *Pauliśa Siddhānta* tables (see table 8). We now have

$$t = \frac{2}{v} \sqrt{21^2 - \left(\frac{21\,\Delta\lambda}{5}\right)^2} = \frac{2}{v}\,\frac{21}{5} \sqrt{(5 - \Delta\lambda)(10 - (5 - \Delta\lambda))}.$$

These rules appear to ignore the variation in latitude that takes place, but the *Sūrya Siddhānta* directs us to find the value of the moon's latitude at first contact from the value of t, to substitute this value and repeat the process till t is constant: that is, as we know the longitude of the moon at the time of first contact, we calculate the latitude and substitute the value so obtained and repeat the process until the results no longer differ.

25. **Solar eclipses.**—Apart from the preliminary calculations involving parallax very little is given about solar eclipses. The *Pauliśa Siddhānta* gives the time of duration as

$$t = \tfrac{3}{4} \sqrt{64 - \Delta\lambda^2}$$

which appears to be obtained from the usual rule $\frac{2}{v} \sqrt{(R_s + R_m)^2 - {\beta_m}^2}$; for $\beta_m = \frac{9}{2} \Delta\lambda$ approximately, and $R_s + R_m = 36'$, and $v = 720/60$ is the difference between the mean motions of the moon and sun in a nāḍikā.

26. **The projection of eclipses.**—"Since, without a projection (*chedyaka*), the precise difference between two eclipses are not understood, I shall proceed to explain the exalted doctrine of the projection," writes the author of the *Sūrya Siddhānta*.*

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rates of the sun's motion in longitude, by making $a = R_c \pm R_m$ and solving for t.

Formulae (iii) and (iv) neglect bt but the *Sūrya Siddhānta* rule is an attempt to account for this term.

* For the Greek treatment of this topic see the *Almagest*, VI, xi–xiii.

In figure 6 let X be the position of the moon at the moment of opposition, then NXS is the circle of position and marks the north and south direction with reference to the moon, while the circle XE' at right angles to NXS marks the east and west direction. The angle $NXP = CXE'$ is the *valana*, which gives the directions of the ecliptic with reference to the 'circle of position' and the east and west line (XE').

In figure 13 the centre of the moon at opposition is at M and Mn ($= 16'$) is its radius. The circle of position is represented by NS and the line EW corresponds to $E'X$ in figure 6. The moon is supposed to be stationary and the centre of the shadow circle is supposed to move from b at the first contact, to e at opposition, to b at last contact, and the problem is to find the locus of *bed*.

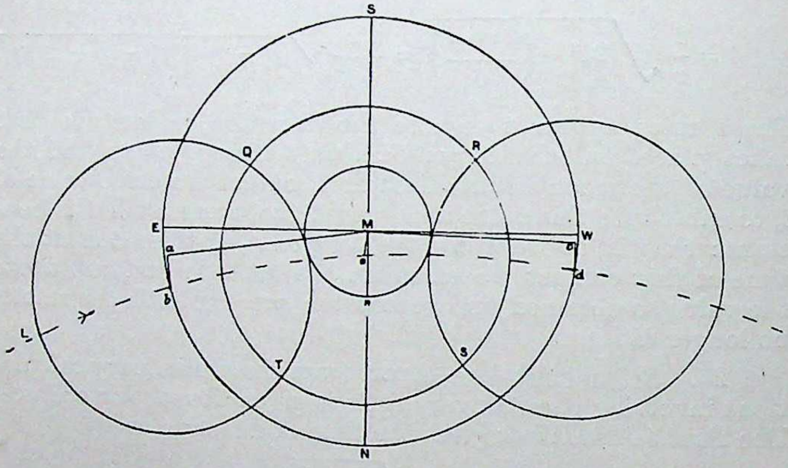

Fig. 13

The radius of the circle $ENWS$, whose centre is at M, is equal to the sum of the radii of the moon, and the shadow ($16' + 41' = 57$) so that the points b and d must lie on this circle Now make the angles EMa, eMN, and WMc equal to the *valana* at first contact, opposition, and last contact respectively, and make ab, Me and cd equal to the latitude of the centre of the moon at those times, due care being taken with reference to the directions. The points b, e, d are thus fixed and the circle drawn through these points is assumed to be the path of the centre of the shadow.

The *Sūrya Siddhānta* concludes the section dealing with this subject with the caution that "This mystery of the gods is not to be imparted indiscriminately."

TABLES.

1. *Cycles, years, months and days.*

		Jyotisha Vedāṅga.	Romaka Siddhānta.	Old Sūrya Siddhānta.	Āryabhata and Puliśa.	Brahmagupta.	Sūrya Siddhānta.
Years in cycle	Y	5	2850	180,000	4,320,000	4,320,000,000	4,320,000
Intercalary months	M_i	2	1050	66,389	1,593,336	1,593,300,000	1,593,336
Omitted tithis	D_0	30	16,547	1,045,095	25,082,280	25,082,550,000	25,082,252
Solar months	$M_\odot$	60	34,200	2,160,000	51,840,000	51,840,000,000	51,840,000
Synodic ,,	M_l	62	35,250	2,226,389	53,433,336	53,433,300,000	53,433,336
Sidereal ,,	M_*	67	38,100	2,406,389	57,753,336	57,753,300,000	57,753,336
Solar days	$D_\odot$	1800	1,026,000	64,800,000	1,555,200,000	1,555,200,000,000	1,555,200,000
Natural ,,	D	1830	1,040,953	65,746,575	1,577,917,500	1,577,916,450,000	1,577,917,828
Tithis	D_l	1860	1,057,500	66,791,670	1,603,000,080	1,602,999,000,000	1,603,000,080
Sidereal days	D_*	1835	1,043,843	65,926,575	1,582,237,500	1,582,236,450,000	1,582,237,828

Note.—$M_\odot = 12\,Y$
$M_l = M_\odot + M_i$
$M_* = M_l + Y$

$D_\odot = 30\,M_\odot$
$D_l = 30\,M_l$
$D = D_l - D_0$
$D_* = D + Y$

$$\left[\begin{array}{l} M_i = M_l - M_\odot \\ D_0 = D_l - D \end{array}\right]$$

2. *Sidereal revolutions of planets.*

	Āryabhaṭa.	Puliśa.	Brahmagupta.	Sūrya Siddhānta.
SUN	4,320,000	4,320,000	4,320,000,000	4,320,000
MOON *	57,753,339	57,753,336	57,753,300,000	57,753,336
MARS	2,296,824	2,296,824	2,296,828,522	2,296,832
MERCURY	17,937,920	17,937,000	17,936,998,522	17,937,060
JUPITER	364,224	364,220	364,226,455	364,220
VENUS	7,022,388	7,022,388	7,022,389,492	7,022,376
SATURN	146,564	146,564	146,567,298	146,568

3. *Revolutions in 4,320,000,000 years of*

	APSIDES.		NODES.	
	Brahmagupta.	Sūrya Siddhānta.	Brahmagupta.	Sūrya Siddhānta
SUN	480	387	..	....
MOON*	488,105,858	488,203,000	232,311,168	232,238,000
MARS	292	204	267	214
MERCURY	332	368	521	488
JUPITER	855	900	63	174
VENUS	653	535	893	903
SATURN	41	39	584	662

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* Puliśa gives 488,219 and 232,226.

4. *The later Sūrya Siddhānta elements.*

	A. Orbits.	B. Sidereal periods.	A ÷ B. Mean daily motion.		Mean distances.	Synodic periods.	Apparent diameters.
	Yojanas.	Days.	Yojanas.	Seconds of Arc.	Yojanas.	Days.	
Moon	324,000	27·321674	11858·7	47,434·9	51,566	29·530879	32′
Mercury	1,043,209	87·969702	11858·7	14,732·3	166,031	115·904166	3′
Venus	2,664,637	224·698568	11858·7	5,767·7	424,089	583·906943	4′
Sun	4,331,500	365·258756	11858·7	3,548·2	689,378	....	32′ 24″
Mars	8,146,909	686·997494	11858·7	1,886·5	1,296,618	779·930555	21′
Jupiter	51,375,764	4,332·320652	11858·7	299·1	8,176,687	398·888859	3′ 30″
Saturn	127,668,255	10,765·773075	11858·7	120·4	20,318,981	378·08611	2′ 30″

Sun's horizontal parallax .. 3′ 59·4″
Moon's ,, ,, .. 53′ 20″
Mean semi-diameter of the sun .. 3250 yojanas or 16′ 12″
,, ,, ,, moon .. 240 ,, ,, 16′ 0″

Semi-diameter of the earth .. 800 yojanas.
Obliquity of the ecliptic .. 24°
Mean distance of earth to moon 51,566 yojanas or 64·46 radii.
,, ,, ,, sun .. 689,378 ,,

(Fleet's estimate of the value of the yojana is $9\frac{1}{11}$ miles. See J.R.A.S., 1907, p. 656).

5. *Divisions of Day.*

	Vipala.	Prāṇa.	Vinādi or pala.	Nāḍi or ghaṭi.	Muhūrta.	Dina, day.	Equivalents in time.	Equivalents in arc.
1 vipala	= 1	....	....	....	....	....	·$4^{sec.}$	·1′
1 prāṇa	= 10	1	....	....	....	....	$4^{sec.}$	1′
1 vināḍi	= 60	6	1	....	....	....	$24^{sec.}$	6′
1 nāḍi	= 3600	360	60	1	....	....	$24^{min.}$	6°
1 muhūrta	= 7200	720	120	2	1	....	$48^{min.}$	12°
1 day	=216000	21600	3600	60	30	1	$24^{hours.}$	360°

6. *Ascensional differences for certain latitudes.*

No.	Signs.		Latitudes / Righ ascensions.	6°	12°	18°	24°	30°	36°	42°	48°	54°	60°	66°
1	Aries ..	Pisces ..	27° 53′ 5″	1° 15′	2° 29′	3° 48′	5° 13′	6° 46′	8° 33′	10° 35′	13° 5′	16° 18′	20° 43′	27° 15′
2	Taurus	Aquarius ..	29° 53′ 19″	2° 14′	4° 31′	6° 53′	9° 28′	12° 19′	15° 35′	19° 23′	24° 8′	30° 29′	39° 43′	55° 51′
3	Gemini ..	Capricornus	32° 12′ 36″	2° 29′	5° 20′	8° 10′	11° 14′	14° 36′	18° 31′	23° 8′	28° 56′	36° 43′	49° 8′	78° 34′
4	Cancer ..	Sagittarius	32° 12′ 36″	2° 14′	4° 31′	6° 53′	9° 28′	12° 19′	15° 35′	19° 23′	24° 8′	30° 29′	39° 43′	55° 51′
5	Leo ..	Scorpio ..	29° 53′ 19″	1° 15′	2° 29′	3° 48′	5° 13′	6° 46′	8° 33′	10° 35′	13° 5′	16° 18′	20° 43′	27° 15′
6	Virgo ..	Libra ..	27° 53′ 5″	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′	0° 0′

7. *Oblique ascensions or periods of risings of signs for certain latitudes.*

No.	Latitudes. / Signs.		6°	12°	18°	24°	30°	36°	42°	48°	54°	60°	66°
1	Aries ..	Pisces ..	26° 38′	25° 24′	24° 5′	22° 40′	21° 7′	19° 20′	17° 18′	14° 48′	11° 35′	7° 10′	0° 38′
2	Taurus ..	Aquarius ..	28° 55′	27° 52′	26° 49′	25° 39′	24° 21′	22° 52′	21° 6′	18° 51′	15° 43′	10° 54′	1° 18′
3	Gemini ..	Capricornus	31° 48′	31° 24′	30° 53′	30° 27′	29° 56′	29° 17′	28° 28′	27° 35′	25° 49′	22° 48′	9° 30′
4	Cancer ..	Sagittarius ..	32° 33′	33° 2′	33° 30′	33° 59′	34° 30′	35° 9′	35° 18′	37° 1′	38° 34′	41° 38′	54° 56′
5	Leo ..	Scorpio ..	30° 53′	31° 56′	32° 59′	34° 41′	35° 27′	36° 56′	38° 42′	40° 57′	44° 5′	48° 54′	58° 30′
6	Virgo ..	Libra ..	29° 3′	30° 22′	31° 41′	33° 6′	34° 39′	36° 26′	38° 28′	40° 58′	44° 11′	48° 36′	55° 8′

8. *Tables of Sines.*

ARCS.	Pauliśa.	Āryabhaṭa.	Brahmagupta.	ARCS.	Pauliśa.	Āryabhaṭa.	Brahmagupta.
3° 45′	7′ 51″	225′	214′	48° 45′	90′ 13″	2585′	2459′
7° 30′	15′ 40″	449′	427′	52° 30′	95′ 13″	2728′	2594′
11° 15′	23′ 25″	671′	638′	56° 15′	99′ 46″	2859′	2719′
15° 0′	31′ 4″	890′	846′	60° 0′	103′ 56″	2978′	2832′
18° 45′	38′ 34″	1105′	1051′	63° 45′	107′ 38″	3084′	2933′
22° 30′	45′ 56″	1315′	1251′	67° 30′	110′ 53″	3177′	3021′
26° 15′	53′ 5″	1520′	1446′	71° 15′	113′ 38″	3256′	3096′
30° 0′	60′ 0″	1719′	1635′	75° 0′	115′ 56″	3321′	3159′
33° 45′	66′ 40″	1910′	1817′	78° 45′	117′ 43″	3372′	3207′
37° 30′	73′ 3″	2093′	1991′	82° 30′	119′ 0″	3409′	3242′
41° 15′	79′ 7″	2267′	2156′	86° 15′	119′ 45″	3431′	3263′
45° 0′	84′ 51″	2431′	2312′	90° 0′	120′ 1″	3438′	3270′

9. *Summary Table* (From H. Jacobi, E.I. i, p. 442).

	Sūrya Siddhānta.	Ārya Siddhānta.	Brahma Siddhānta.
Sun's revolutions in a yuga	4,320,000	4,320,000	4,320,000
Civil days ,, ,,	1,577,917,828	1,577,917,500	1,577,916,450
Lunar tithis ,, ,,	1,603,000,080	1,603,000,080	1,602,999,000
Moon's synod. rev. ,, ,,	53,433,336	53,433,336	53,433,300
,, sid. ,, ,, ,,	57,753,336	57,753,336	57,753,300
,, anom. ,, ,, ,,	57,265,133	57,265,117	57,265,194·142
,, nodes ,, ,, ,,	−232,238	−232,226	−232,311·168
,, apsides ,, ,, ,,	488,203	488,219	488,105·858
Jupiter's ,, ,, ,,	364,220	364,224	364,226·455
Rev. of sun's apsis ,, ,,	387	....	480
Place of sun's apsis at o kali yuga	77° 7′ 48″	78° 0′ 0″	77° 45′ 36″
,, ,, moon's ,, ,, ,,	90° 0′ 0″	90° 0′ 0″	125° 29′ 46″
,, ,, Jupiter's ,, ,, ,,	0° 0′ 0″	0° 0′ 0″	329° 27′ 36″
Circum. of sun's epicycle	14° to 13° 40′	13° 30′	14° to 13° 40′
,, ,, moon's ,,	32° ,, 31° 40′	31° 30′	31° 36′ to 30° 44′

10. *Modern Values.*

Mean distance.			SIDEREAL PERIOD.		Synodic period in days. *	Sidereal mean daily motion.	Inclination to ecliptic.	Equatorial semi-diameter. *	Mean longitude of the node.	Mean longitude of the perhelion.	Arc of retrogression. *	
			Mean solar days. *	Tropical years.								
SUN	☉	....	....	....	....	....	....	16′ 1·18″	....	....	..	☉
MOON	☾	....	27·3217	....	29·531	....	5° 8′ 43·3″	15′ 31·87″	....	....	..	☾
MARS	♂	1·5237	686·9797	1·8809	779·94	1,886·52″	1° 51′ 0·9″	4·68″	48° 55′ 56·9″	334° 34′ 5·4″	18°	♂
MERCURY	☿	0·3871	87·9693	0·2408	115·88	14,732·42″	7° 0′ 11·6″	3·34″	47° 22′ 16″	76° 11′ 42·8″	12°	☿
JUPITER	♃	5·2028	4332·588	11·8622	398·88	229·13″	1° 18′ 27·7″	1′ 37·36″	99° 37′ 47·9″	13° 1′ 3·6″	9°	♃
VENUS	♀	0·7233	234·701	0·6152	583·92	5,767·67″	3° 23′ 37·8″	8·40″	75° 57′ 2·2″	130° 25′ 52·7″	16°	♀
SATURN	♄	9·5388	10759·20	29·4577	378·09	120·45″	2° 29′ 29·6″	1′ 24·75″	112° 56′ 57·3″	91° 27′ 39·2″	6°	♄
EARTH	⊕	1·0000	365·2564	1·00004	....	3548·19″	0° 0′ 0″	....	....	101° 32′ 50·9″	..	⊕

Solar parallax 8·8″.
General precession 50·2564″ + 0·000222″ $(t - 1900)$.
Obliquity of the ecliptic 23° 27′ 8·26″ – 0·4684″ $(t - 1900)$.
Equatorial horizontal parallax of the moon 57′ 2·63″.
Mean distance of earth to moon 384,411 kilometres = 238,862 statute miles or 60·2678 radii.
Mean distance of earth to sun 149,504,201 kilometres = 92,897,416 miles.

Length of year:
  Tropical .. 365·24219879 – 0·0000000614 $(t - 1900)$ days.
  Sidereal .. 365·25636042 – 0·0000000011 $(t - 1900)$ days.

Length of month:
  Synodical .. 29·530588 days = $29^{\mathrm{d}}\ 12^{\mathrm{h}}\ 44^{\mathrm{m}}\ 2{\cdot}8^{\mathrm{s}}$.
  Sidereal .. 27·321661 ,, = $27^{\mathrm{d}}\ 7^{\mathrm{h}}\ 43^{\mathrm{m}}\ 11{\cdot}5^{\mathrm{s}}$.
  Anomalistic .. 27·554550 ,, = $27^{\mathrm{d}}\ 13^{\mathrm{h}}\ 18^{\mathrm{m}}\ 33{\cdot}1^{\mathrm{s}}$.

Length of day:
  Sidereal .. $23^{\mathrm{h}}\ 56^{\mathrm{m}}\ 4{\cdot}091^{\mathrm{s}}$ of mean solar time.
  Mean solar .. $24^{\mathrm{h}}\ 3^{\mathrm{m}}\ 56{\cdot}555^{\mathrm{s}}$ of sidereal time.

Earth:
  Equatorial radius 6378·388 kilometres = 3963·34 statute miles.
  Polar radius .. 6356·909 kilometres = 3949·99 statute miles.

(All these values except those marked * are taken from the *American Nautical Almanac* for the year 1919).

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Journal, Vols. 1—73, 1832—1904.
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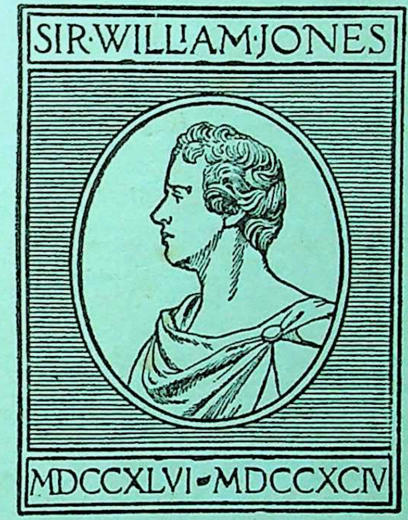
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PROCEEDINGS OF THE INDIAN SCIENCE CONGRESS.

The Sixth Annual Meeting of the Indian Science Congress was held in Bombay, from January 13th to 18th instant. After the Patron, His Excellency Sir George Lloyd, G.C.I.E., D.S.O., Governor of Bombay, had welcomed the visitors in a short speech, the President Lt.-Colonel Sir Leonard Rogers, M.D., F.R.C.P., F.R.C.S., F.R.S., F.A S.B., I.M.S., delivered his address.

Presidential Address.

When I received the flattering invitation to preside over the Indian Science Congress at Bombay, I felt that I was unfitted for the position, because medical science had not hitherto been included within the scope of the meetings; but on learning that it was desired to include a section on medical research this year, I was very glad to accept the honourable and responsible position of president. On considering the question of a suitable subject for my presidential address I naturally turned to the relationship of medical research to other sciences as affording ample scope, and being appropriate to such an audience as this. Greater difficulty arose in deciding how to deal with such a large subject, as a general treatment might be too diffuse to be of much interest. Realizing that I owe my present onerous position to having been fortunate enough to make some practical life-saving advances in tropical medicine, I feel that I shall be most likely to interest my audience by illustrating the subject with some account of my own researches in which the collateral sciences of physiology, chemistry and physics were utilized in solving problems arising in the treatment of deadly diseases: for I feel sure that pure scientists will always rejoice in seeing their discoveries being made practical use of by medical research workers. The immense advantages that modern medicine has derived in the last few decades from advances made in closely related sciences are too numerous even to be mentioned, but some of those concerning tropical diseases may be referred to. Thus we have zoological work on disease-carrying insects, such as mosquitoes in malaria, yellow fever, and dengue, sandflies of pappataci fever, tsetse-flies of sleeping sickness, and lice of relapsing, typhus and trench fevers. Chemical work on emetine and other alkaloids of ipecacuanha root, which drugs have proved of such immense value in controlling amoebic dysentery and liver abscess; the preparation of soluble salts of the unsaturated fatty acids of chalmoogra and hydnocarpus oils in forms suitable for subcutaneous and intravenous injection for use in the treatment of leprosy, and also during the last year of a similar preparation from codliver oil, which appears to be of considerable value both in leprosy, and in that greatest scourge of suffering humanity, tuberculosis, which is estimated to destroy one-seventh of mankind mostly when in the prime of life: a subject I shall be dealing with in the medical research section, and for the chemical portion of the work on which I am indebted to Dr. Sudhamoy Ghosh, D.Sc., working with a grant from the Indian Research Association. Again much work has been done on the vitamines which prevent beri beri and scurvy, in connection with which Captain Shorten, I.M.S., has at my suggestion tested the value of the Quetta sun-dried vegetables of Mr. and Mrs. Howard, with important results which will also be reported in the medical research section. Pellagra may also possibly belong to the diet deficiency diseases, although in view of the mouth lesions I suggest that this affection should be further studied bacteriologically on the lines which have enabled me to cure many cases of sprue by oral streptococcal vaccines, an advance which has recently been confirmed by Dr. Nicholls of the bacteriological institute at Colombo. Once more sodium antimony tartrate first shown by Plimmer and Thomas to be very active against trypanosomes, I have recently found to be somewhat safer and less irritating to the tissues than tartar emetic in the treatment of the formerly deadly kala-azar, the mortality from which in all but very neglected cases has now been reduced from about 90 per cent to nearly the vanishing point. During the last few months, I have been using in kala-azar a colloidal antimony sulphide very kindly made for me by Dr. F. L. Usher of Bangalore at the suggestion of our energetic secretary Dr. Simonsen, and have found it to be even more effective and much less toxic than the antimony salts already mentioned, and I think it may also prove of great value in African trypanosomiasis, the later stages of which are known as sleeping sickness, the greatest scourge of large areas of tropical Africa. All these are matters of great interest and practical importance, but the subject which I propose to deal with at somewhat greater length to-day, is one regarding which probably but little is known outside the medical profession except that a great reduction in the death-rate has been brought about in recent years in perhaps the most justly dreaded disease of India, namely cholera. I propose to give you a brief account of my prolonged researches extending over more than a decade, and dealing with several distinct problems by means of a variety of methods of research, physiological, physical and chemical; as I think this work will best illustrate my theme of the value of various collateral sciences in medical research.

EARLY RESEARCHES ON CHOLERA.

I must first briefly refer to some points in the history of cholera so that you may be able to realize the state of our knowledge when I commenced my investigations. At the Bombay Medical Congress in 1909, I gave a short lecture with maps on the history of the cholera epidemics which spread to Europe during the nineteenth century, and pointed out the valuable stimulus they gave to sanitary progress in England, the introduction of pure filtered water supplies for London having largely resulted from the demonstration of the waterborne nature of the diseases especially by Snow, just as Bombay owes its Parel bacteriological laboratory largely to the plague outbreak in India. Nevertheless the old airborne theory died very hard, and it was not until Ernest Hart, at the first Indian Medical Congress in Calcutta in 1894, poured ridicule upon it, that the absurd army regulation ordering troops during cholera prevalence to march at right angles to the wind finally disappeared from the military rules. In 1883 a new era dawned when a German bacteriologist announced the discovery of the comma bacillus of cholera during an outbreak in Egypt. The organism is indeed present in such enormous numbers in the rice-water stools of severe cholera cases that it could scarcely be overlooked by a well-trained bacteriologist, who, however, were very few in those days, and it has often been asked why the medical profession in India left it to a foreigner to make this important discovery. And thereby hangs a tale. In 1879 Dr. N. C. Macnamara, I.M.S.—we were allowed the privilege of calling ourselves doctors in those days—of Calcutta, afterwards Vice-President of the Royal College of Surgeons of England, published a comprehensive history of cholera which is still the standard work on the subject. He had for long been investigating the disease, and had recorded strong evidence to show that the infection was spread by water contaminated with the stools of cholera cases, and had clearly stated that the causative organism would be found in the evacuations. A few years later he went on leave and studied the then young science of bacteriology at his own expense, with a view to tackling the subject on his return to India. Having thus qualified himself for the task by long experience of the disease and technical knowledge, in February 1883 he applied to the India Office for facilities for pursuing his investigation on his return to Calcutta, but received an absolute refusal to entertain his request. The same Government, however, within a year gave to a German bacteriologist, who had in the meantime discovered the comma bacillus in Egypt, every possible facility to investigate cholera in India. I have in my possession Dr. Macnamara's own account of this sad episode, which reflects so little credit on Indian administration. I am glad to say he has lived to see

German culture so completely exposed by the great war that the recurrence of such a discreditable event seems scarcely possible in the future. This episode is, however, typical of the want of encouragement Indian Medical Service investigators met with up to two or three decades ago, which has now happily given place to a very different spirit, and the immense value of the research work done by the bacteriological department, to which I have not myself the honour of belonging, in the last few years is reflected in the bestowal of four decorations among the thirteen original members of that small but growing body of medical scientists.

The establishment of the comma bacillus as the cause of cholera greatly strengthened our hands as far as regards preventative measures against the disease, and its epidemic spread both beyond India and by pilgrimages within the country has been much more efficiently controlled during the last two or three decades than formerly, although the sanitary arrangements for the prevention of the occurrence at and spread from Puri in Orissa, still leave much to be desired, as shown by the very serious epidemic which occurred at the last especially largely attended Jaganath festival in 1912. Greig then showed that of the recovered pilgrims leaving the hospital no less than 36 per cent were cholera carriers, and a number of outbreaks took place in the Central Provinces after their return, although unfortunately my suggestion to the Sanitary Commissioner with the Government of India to investigate that spread was not adopted, although an expert bacteriologist was available for the purpose, and a great opportunity was lost.

As the cholera organism is a delicate one and easily destroyed by weak acids and chemical disinfectants, while it exists in enormous numbers in the intestines, but only in comparatively small numbers in the internal organs, it was at first hoped that the oral administration of intestinal disinfectants might cut short the disease. Unfortunately this hope was disappointed, and I found in the course of my work that the dilute mineral acids, at one time given for that purpose, were actually harmful by increasing the death-rate from suppression of urine. An important sanitary advance was however made by Dr. Hankin's use of permanganates to disinfect wells for controlling cholera outbreaks.

The treatment of cholera then at the beginning of the twentieth century remained much as it was seventy years before when Latta and Mackintosh in Endinburgh in 1831 introduced the plan of injecting large quantities of normal saline solution into the veins to combat the collapse stage of cholera. This brilliant idea just failed to be a great discovery because no means was then found of retaining the fluid in the circulation, so that the apparently miraculous immediate effect of reviving the patient as one from the dead was usually followed by fatal recurrence of the terrible drain of fluid from the system. At the time I commenced my investigations the method was seldom used, as shown by the fact that a search through the records of the Calcutta European General Hospital from 1895 to 1904 showed no case in which large saline intravenous injections were given, while the mortality among 95 cases in those nine years reached the appalling figure of 87·4 per cent. Indeed it was generally recognized that once an European patient reached the collapse stage in cholera recovery scarcely ever took place.

Recent Researches on the Treatment of Cholera.

As the first whole-time professor of pathology in Bengal, the home of cholera, who stuck to unlucrative research work for any length of time, this fell disease naturally attracted my attention, but it was not until after the completion of the first edition of my work on Fevers in the tropics, the collection of material for which occupied me for twelve years, that I was able to take up serious work on cholera in 1908. I had previously made a number of blood counts and, with the help of my friend Major Megaw, I.M.S., had studied in 1906 Latta and Mackintosh's plan of injecting large amounts of normal or isotonic salt solutions, that is one containing the same proportion of salts as the normal blood, controlling the quantities injected by special blood, and blood pressure examinations, in the hope that with the aid of these modern methods better results would be obtained. This hope was largely disappointed as the mortality only fell from 59·0 per cent during the previous eleven years to 51·9 per cent in 1906, and the method, which is a time-consuming one, was once more abandoned as of little service.

On thinking the matter over while on furlough, it occurred to me that on the physiological principle that a high salt content tended to retain fluid in the blood, it would be worth while to try a stronger salt solution, and on return from leave with renewed energy at the end of 1907 I determined to put this theory to the test. I may perhaps be pardoned for digressing for a moment to remark that very shortly after my last three periods of furlough I discovered respectively the development of the flagellate stage of the Leishman-Donovan body, furnishing an important clue to the probable mode of infection of kala-azar, the hypertonic saline treatment of cholera, and the emetine treatment of dysentery : an experience which I trust will encourage Indian administrations to give liberal and frequent leave to research workers to enable them to keep as fit and fresh as possible for their important and exacting labours. Up to this time the strength of salines generally advised in cholera was 0·6 per cent, although recent physiological text-books have raised the figure for normal saline to 0·85 per cent. As I wished to give a hypertonic solution, that is one containing more salt than the normal blood, I doubled the former strength and used a 1·2 per cent of sodium chloride, or 120 grains to a pint, to which I afterwards added 4 grains of calcium chloride, because physiologists have found the latter salt to be beneficial to the heart. Captain, now Lt.-Colonel, Mackelvie, I.M.S., very kindly carried out the hypertonic injections on the cases under his care while I made a series of observations on the blood to be related presently. Cholera, plague and septic cases were in those days treated in a dark basement of the Medical College hospital, requiring artificial light in the daytime, but the results were soon evident in the cheering sight of a number of convalescent cholera patients for the first time within the memory of a faithful old nurse who laboured for nearly ten years in these dismal surroundings. They may be summarized in a sentence by saying that by using two teaspoonfuls of common salt to a pint of water instead of one, the mortality of cholera was nearly halved. Nothing could well be simpler, yet nearly eighty years had elapsed since salines were first injected intravenously in cholera before the physiological principle of using a hypertonic instead of an isotonic solution was established. It was at once clear to me that a great advance had been made which stimulated me to persevere with my investigations of the blood changes in cholera, so as to place the whole subject on a firm scientific basis.

THE BLOOD CHANGES IN CHOLERA AS A BASIS FOR THE HYPERTONIC TREATMENT.

In the first place I estimated the amount of chlorides in the blood before and after saline injections in a series of cases, and found that in the most severe cases they might even be below the normal point in spite of the great concentration of the blood, thus establishing a vicious circle and leading to further rapid loss of any isotonic solution injected into the veins. I further established that the hypertonic saline did materially raise the salt content of the blood, and to the greatest extent in recovering cases, which explained both the failure of the former isotonic and the success of the hypertonic solutions.

Another important point was to estimate the amount of fluid lost from the blood in cholera, so as to ascertain if the amount was in proportion to the severity of the case, and to learn how much salt solution it is necessary to inject to replace the loss. For this purpose I centrifuged a few drops of defribinated blood obtained by pricking the finger tip in a graduated capillary tube, and measured the volume of the solid corpuscles and of the fluid serum. By comparing the figures obtained with those of normal blood the percentage of fluid lost from the blood could be estimated. For example in a severe case only 18 out of the original 55 per cent of serum remained, showing a loss of no less than 67 per cent of the fluid portion of the blood as a result of the copious evacuations. A series of such observations showed that in mild cases of cholera not showing any serious collapse an average of 35 per cent of the serum was lost; in collapse cases recovering after the hypertonic saline injections the loss averaged 52 per cent, while in extremely severe cases, who were lost in spite of the new treatment, the figure averaged no less than 64 per cent, or almost two-thirds of the fluid of the blood. I have seen cases of cholera in which the blood was so thick that on opening a vein a drop of black blood slowly exuded having the consistency almost of tar: a condition which must rapidly terminate fatally if not quickly relieved. By repeating these estimations immediately after several pints of saline had been run rapidly into a vein in collapsed cholera cases, I was able to ascertain the quantities required to restore the normal fluidity of the blood, and found them, as I had suspected, to be much greater in severe cases than had formerly been given when isotonic solutions were in use. The haemocrite, however, is too much of a laboratory instrument to be generally available so a simple bedside method was needed. I therefore made use of Lloyd-Jones' method of estimating the specific gravity of the blood by means of a series of solutions of glycerine in water in small labelled bottles into which small drops of blood are gently blown from a capillary tube, and that in which one just floats is noted, which gives the required estimation. By carrying out this simple and rapid test at the same time that the more accurate haemocrite method was used in a series of cases, I worked out the rule that when the specific gravity of the blood is raised from the normal point of 1056 in Indian patients to 1063, then three pints of hypotonic saline should be injected into a vein; a figure of 1064 indicates the use of four pints and one of 1065 demands five pints, while with still higher figures as much as six pints may often be injected with great advantage to the patient. Whenever the pulse tends to again fail the test is repeated as a guide to further treatment, and in several extremely severe cholera cases over thirty pints of fluid have thus been injected in the course of several days with ultimate success in saving the lives of the patients. This test has been in daily, morning and evening, use in two thousand cases in my cholera wards in Calcutta, situated in a special isolation block since 1909, thanks to the late Sir Pardey Lukis, whose loss to medical science in India which he did so much to encourage is almost irreparable, and to whom I am personally deeply indebted for giving me charge of these wards to facilitate my researches on cholera and dysenteries.

PERMANGANATES AND OTHER DRUGS IN THE TREATMENT OF CHOLERA.

The success of the hypertonic saline injections in enabling the collapse stage of cholera to be largely overcome opened the way to a trial of drug treatment such as had never before been possible; for it is clear that unless the circulation can be restored and maintained drugs given by the mouth will not even be absorbed, and can have no chance of exerting their beneficial action. Great care is required to make such tests reliable on account of the numerous sources of fallacy in estimating the effects of a given treatment. For example, I found from an examination of the Calcutta Medical College records of the eleven years before I commenced my new treatment that the case mortality was 66·7 per cent in the first quarter of the year, but steadily declined to only 46·7 per cent in the third quarter. Again in a Karachi epidemic the death-rate in the first one hundred cases was 79 per cent, and in the last one hundred only 40 per cent, or one half the first figure. Unless this is borne in mind a drug tried in the latter part of an outbreak may be given credit for what is only the natural decrease in the severity of the disease. For this reason, I only compare whole year's records or similar seasons' cases, or better still use a new drug in every other case in addition to the routine treatment, the remaining half of the cases then serving as a control. When two simultaneous series one with and the other without the new remedy have been carefully recorded—for which purpose I use specially printed forms, the regular filling in of all the headings and columns of which ensures completeness of the notes in every particular—the two series can be compared as regards all points which previous studies have shown to be the causes of the high mortality. To take an example of this method of investigation, the late Sir Lauder Brunton, some years ago, advocated on physiological grounds the use of atropine in cholera, but was only able to try it in two mild cases with inconclusive results. I therefore gave the drug hypodermically in addition to the routine treatment in every other case of cholera in my wards for a whole year, with the result that the mortality was much lower in the atropine series, while a careful comparison of the two sets of cases as regards their severity showed them to be strictly comparable. I have therefore added atropine to my system of treatment with, I am sure, beneficial results. In a similar manner emetine was found to be useless in cholera.

Another point I wish to emphasize is the importance of carefully studying one's failures rather than being elated with any success, as the further progress I have still to relate is mainly due to my adopting that practice. For the last ten years I have tabulated with the aid of shorthand, the value of which in my work I cannot speak too highly of, all the more important points of my cholera cases, now amounting to just over 2,000, and have closely studied the records of all fatal ones to ascertain the reasons for the failures with a view to finding means of lessening them. The following examples will illustrate some of the results thus obtained.

After an experience of a year and a half of the hypertonic treatment, I realized that something more was required if the mortality was to be still further reduced. The failures appeared to me to be largely due to a recurrence of the collapse on account of absorption of the toxins produced by the cholera bacillus in the intestinal canal with the restoration of the circulation after the saline injections. Now the toxins are contained in the bodies of the innumerable bacilli and are set free when they break up, as they do in enormous numbers, for it has been shown that no less than 99 per cent of comma bacilli die in culture tubes within forty-eight hours. The use of intestinal antiseptics may very possibly add to the toxin absorption by killing the bacilli, which is, I believe, one of the reasons for their failure as already stated. I therefore sought for some method of destroying the toxins themselves while still unabsorbed in the bowel, and, bearing in mind that they are largely albumoses and other unstable albuminous products of the metabolism of the organisms, and that such substances are readily destroyed or rendered inert by oxidization, I experimented with various oxidizing agents, and particularly with permanganates, which are well known to rapidly destroy in vitro the albumoses of snake venoms: a point at which I had previously worked. I was thus able to demonstrate that several times a lethal dose of dead comma bacilli containing the toxins could be neutralized by a small quantity of permanganates. A trial of large doses of permanganate of potash in pill form by the mouth, as much as one hundred grains sometimes being given in the course of several days, in addition to the hypertonic treatment, reduced the mortality of cholera during a year's use from 32·6 to 23·3 per cent, and it has now been used for over nine years in my wards with increasingly favourable results. Permanganate pills have also been used in cholera epidemics in both the Bombay Presidency and the Central Provinces, in villages under conditions in which the saline treatment was not practicable, and favourable results have been reported, although of course it cannot by itself save the most severe cases with extreme collapse

ALKALIES IN THE PREVENTION OF FATAL RENAL COMPLICATIONS.

There still remained one very important line of investigation, which has recently led to a further substantial reduction of the death-rate of cholera by enabling the common and most deadly suppression of the renal functions to be largely averted. I know of nothing more disheartening than after successfully maintaining the circulation by hypertonic salines through a life and death struggle for several days and nights, to be unable to get the kidneys to resume their functions, with ultimate loss of the patient. Before the hypertonic treatment many of the few patients who recovered from collapse eventually died of renal failure, and a careful study convinced me that the losses from this cause were reduced to some extent by the saline injections in spite of so many severe cases being tided over the collapse stage to face the dangers of suppression of urine. Further diurnal estimations of the blood pressure and the specific gravity of the blood afforded valuable indications for further saline injections to aid the renal secretion. Nevertheless, as the losses from collapse were steadily reduced by the various measures I have related, the death-rate from kidney failure continued much the same and now became the most important remaining cause of loss of life, and it became clear that some factor remained which was not clearly understood.

Light was first thrown on this problem by an American physician Dr. Sellards working in the Philippines, who suspected a diminution in the alkalinity of the blood, or acidosis as it is generally termed, because he found that large doses of alkalies by the mouth failed to make the urine alkaline as it would do in health. He therefore added sodium bicarbonate to the saline solution used in cholera for intravenous injections and obtained a marked reduction in the death-rate from renal failure. In 1911 Major Megaw when acting for me in Calcutta read Sellards' work and tried alkaline solutions intravenously in cases of cholera with suppression of urine, but with disappointing results, the measure being apparently too late, once this complication had become established. Early in 1912, I therefore commenced an investigation of the changes in the alkalinity of the blood in cholera, which Sellards had not then done, and finding an extreme degree of reduced alkalinity in all cases with fatal kidney trouble, with the help of Captain Shorten, I.M.S., and later of Rai Satish Ch. Banerjee Bahadur of the physiological department, I made a long series of such estimations in cholera cases, with the result of demonstrating that a very marked degree of diminution of the alkalinity of the blood occurred in all cholera cases, while once it reached the extreme degree of $\frac{N}{100}$ from a normal of about $\frac{N}{25}$ fatal suppression of urine took place in spite of very copious alkaline injections. It thus became clear that in all severe cholera cases sodium bicarbonate should be added to the hypertonic saline solution as a routine measure to combat the acidosis from the first, and prevent it reaching a dangerous degree. The results of this addition to the treatment was soon apparent, and after three years' use of the alkaline solutions the death-rate from renal complication among nearly six hundred cases had fallen to 2·98 per cent from a figure of 11·1 per cent during the previous three years, or a reduction of 74 per cent in the losses from this deadly complication, and the last remaining cause of death in cholera was thus largely conquered. Captain Shorten has recently shown that in addition to acidosis there is also a retention of phosphates in cholera, which can be reduced by the administration of calcium salts in the form of lime water; but I have not yet been able adequately to test this hypothesis. From this point of view calcium permanganate may be preferable to the potassium salt, but in earlier work I found the calcium salt to be less convenient on account of its extremely hygroscopic nature; but it is worthy of further consideration.

THE DIMINUTION IN THE MORTALITY OF CHOLERA.

I fear I shall have wearied you with this long account of my researches on cholera, but the results may be very briefly summarized in the following table showing the mortality under the different forms of treatment, or rather the continued elaboration my system of treatment with increasing knowledge derived from combined clinical and pathological investigations extending over twelve years, and culminating in a reduction of the mortality between 1895 and 1905 before I began work of 59·0 per cent to one of 19·1 per cent between 1915 and 1917 or one-third of the former rate, while in 1917 among 208 cases it was but 14·9 per cent, or one-fourth of the earlier figure; although all cases admitted moribund and dying before a saline injection can be given, those coming late in a hopeless state from suppression of urine and very young and very old persons without the stamina to allow the treatment to have a fair chance are included. I therefore think it may fairly be claimed that cholera has now been robbed of most of its terrors by simple scientific investigation with the aid of physical methods in the use of the haemocrite and specific gravity test; chemical research in the use of permanganates to destroy the toxins in the bowel, and alkalies to combat the deadly acidosis and physiological principles leading to the use of atropine and the all-essential hypertonic saline injections. More may yet be done, but sufficient has already accrued to prove the inestimable life-saving and economic value of medical research work, and to encourage both administrative authorities and philanthropists to look on liberal expenditure on medical research as the best possible use of public and private money.

TABLE OF CHOLERA MORTALITY UNDER DIFFERENT METHODS OF TREATMENT.

Years.	Cases.	Deaths.	Mortality.	Recoveries.
NORMAL SALINE SUBCUTANEOUSLY AND PER RECTUM.				
1895 to 1905	1,243	788	59·0%	41·0%
NORMAL SALINES INTRAVENOUSLY.				
1906	112	57	51·9%	49·1%
NORMAL SALINE SUBCUTANEOUSLY AND PER RECTUM.				
1907	158	94	59·5	40·5
HYPERTONIC SALINES INTRAVENOUSLY.				
1908 to 7-1909	294	96	32·6%	67·4%
HYPERTONIC SALINES PLUS PERMANGANATES.				
8-1909 to 1914	858	222	25·9%	74·1%
HYPERTONIC SALINES, PERMANGANATES AND ALKALIES.				
1915 to 1917	638	122	19·1%	80·9%

THE FUTURE OF MEDICAL RESEARCH IN INDIA.

The great lesson to be derived from the researches on cholera which I have related is the importance of combined clinical and pathological investigations. So strongly do I hold the necessity of medical research workers being in the closest possible relationship with large hospitals to enable them to work on practical lines that I regard Pasteur's great discovery of his preventative treatment of hydrophobia as having been a curse rather than a blessing to India, because it has led to three important research laboratories being placed on remote hilltops for the sake of the relatively insignificant mortality from hydrophobia to the grave detriment of work on all the more important tropical diseases. Now that the treatment of hydrophobia and other bacteriological methods can be carried out in the plains with the help of a refrigerator (and where necessary a temperate room), as is being done at the present time in Rangoon, no excuse for further repetitions of this grave mistake remain. Unfortunately Assam rejected the opportunity which Rangoon took advantage of, and now that the terrible kala-azar is again ravaging the Sibsagar district, cases have to be imported into Shillong to enable the one research worker of the province, who is tied to the Pasteur Institute for want of an assistant qualified to carry out the routine hydrophobia treatment, to have some slight opportunity of tackling the greatest problem of Assam and other large areas of India.

The serious disadvantage which so many of the members of the bacteriological—or as it should be called medical research—department now labour under by their divorce from large hospitals in the plains will be partly removed when the schools of tropical medicine in Calcutta and Bombay are opened, when team work so essential to the solution of the larger medical problems will be possible. In addition, all the larger hospitals should have whole-time pathologists, both to enable the abundant clinical material they contain to be made available for research purposes, and also to allow the clinical staff and the patients to have the immense advantages in the diagnosis and vaccine and other lines of treatment which a bacteriological laboratory affords through recent advances in our knowledge of medicine. For example, fevers and dysenteries are the two great causes of disease and death in India, but it is only with the help of microscopical examinations that they can be rapidly diagnosed and efficiently treated, and without this aid even the most experienced physicians too often cannot do full justice to their patients. Until recently the professors of pathology in our medical colleges have been also physicians, and naturally spent most of their time in clinical work and general practice. and with rare exceptions, such as McConnell of Calcutta, added not little to our knowledge of the pathology of tropical diseases. It was only in 1899 that the first whole-time pathologist was sanctioned for the Calcutta Medical College, and fortunately for me the previous incumbent soon gave it up for the more attractive and lucrative clinical line. During the last nineteen years I have had unrivalled opportunities for combined clinical and pathological research, although the expenses of living in Calcutta are so great that I could not have afforded to retain the post on the pay it carries and continue my investigations, but for the accident that I married late in life; surely not a very satisfactory state of affairs to which I shall return immediately. The access of pathologists to the clinical material necessary for their researches may sometimes be a difficult problem, although as a rule clinicians are quite willing to give the necessary facilities. Personally I am especially indebted to a long series of superintendents and resident surgeons of the Calcutta European General Hospital for opportunities, without which the material for my book on fevers in the tropics could never have been accumulated. For some researches, however, more complete control of clinical cases is required, and this urgent need led me with the invaluable help of Sir Kailash C. Bose to collect the money required to build the Carmichael hospital for tropical diseases as an integral part of the Calcutta School of Tropical Medicine. This will allow of the cases of any special disease under investigation to be placed at the disposal of a particular research worker to the necessary degree without his being burdened with the charge of clinical material of all kinds as in former days to the detriment of his research work. In future I understand pathologists of our medical colleges will be supplied from the bacteriological or research department, and will make the subject their life-study, and not be eligible for clinical posts. In order to get the medical officers with the highest abilities and scientific training required for success in research to devote their lives to it, and to abandon the much more lucrative clinical side of medicine, it will be absolutely necessary to give them salaries in proportion to the long and expensive scientific training of from six to eight years, which they receive after finishing their general school education.

THE NEED OF LIBERAL ENDOWMENTS OF MEDICAL RESEARCH IN INDIA.

Lastly, I wish to draw attention to the great life-saving and economic importance of such investigations as those which I have related on cholera and many others which might be mentioned; as when this is fully realized by the public, endowments of medical research will surely be forthcoming in India on a far larger scale than hitherto. Bengal and Bihar have generously given me seven lakhs for the Calcutta School of Tropical Medicine, half of which has been expended on the Carmichael hospital for tropical diseases, and the remainder will be used for medical research and the partial upkeep of the hospital under a governing body of medical experts. In addition the Tea, Jute and Mining Associations are contributing Rs. 60,000 a year for the support of three additional workers to investigate on practical lines those diseases which affect the value of the labour forces. Bombay has always been noted for the liberality of her citizens, so I confidently appeal to this great city to do at least as much for my friend Colonel Liston's school here, which he has laboured so long and patiently to found in connection with the Parel laboratory.

But I also desire to make a still wider appeal. The late Sir Pardey Lukis, one of the ablest and far-seeing administrators the Indian Medical Service has ever produced, founded the Indian Research Fund Association, to which the Government of India give the large sum of five lakhs yearly. It was hoped that this annual grant would have been materially increased by liberal contributions from the Princes and noblemen whose territories will benefit equally with those under British rule from medical research, and the wealthy citizens of India, but I understand that this hope has been sadly disappointed, mainly no doubt owing to Indian philanthropy having been rightly diverted during the war into other channels. Now that the world-wide devastation and the destruction of irreplaceable human life has at length ceased, I should like to see the flow of money diverted to the noble object of saving life by means of a great extension of medical research, and I can conceive of no more fitting thank-offering for the delivery of the world from the greatest menace that has ever threatened modern civilization. What is wanted is an Indian Rockefeller to come forwa d with a crore or two of rupees, backed by large contributions from many others, to be devoted to the aid of genuine medical research all over India independently of race or position, under the control of a governing body, the chairman and a large majority of whom should be scientific experts. I feel confident that practical philanthropy of this nature, by diminishing suffering and disease, and giving better health to the masses, will be of more real benefit to India than any so-called boons which have ever been dreamt of. Legacies for such work will no doubt be welcomed by the Indian Research Association at Simla, but those who give liberally during their lifetime will have the far greater satisfaction of seeing for themselves the seed they sow in faith bearing fruit abundantly. As example is better than precept I may mention that I am giving as much as the most liberal donors to the Calcutta School of Tropical Medicine, and hope to be able to do still more for medical research in the near future, so I am not asking others to do anything I am not willing to do myself to the limits of my power. In addition to the rich Princes and noblemen who ultimately derive their wealth from the agricultural labourer, I especially appeal to those who have made their fortunes in commercial enterprises to do all they can to help in this practical way the labour forces to whom they so largely owe their prosperity; so it is to the large commercial towns that we must also look for the help we require to bring the blessings of medical research to the aid of the hundreds of millions of patient toilers of India.

Section of Agricultural and Applied Botany.

President:—The Hon. Mr. G. F. Keatinge, C.I.E.

Presidential Address.

Some Economic Factors affecting Agricultural Progress.

It is my pleasing duty to welcome you here to this session of the Agriculture and Applied Botany Section. We have before us twenty papers on a variety of subjects connected with Agriculture, and I have no doubt that we shall have some very interesting discussions on these papers.

I much appreciate the compliment that has been paid to me in asking me to preside over this Section of the Science Congress, the more so since I cannot claim to be a scientific investigator. During the past 25 years, however, I have had occasion, first as a Revenue Officer and then as an Agricultural Officer, to study the economic condition of the cultivators in this Presidency, and I propose to address you on some economic factors which I conceive to be of fundamental importance in the matter of agricultural progress. Political Economy has, I believe, been described as the "dismal Science." I fear that you may find my remarks dismal, but I hope that you will not find them unscientific. My excuse for addressing you on a subject somewhat remote from Physical Science is that I think that all you agricultural workers in this country, whether you are agriculturists, chemists, botanists or engineers, are often compelled to realize that the results of your labours, the practical application of the methods which you advocate are largely discounted and severely handicapped by existing economic difficulties. You discover something which should be of great value to the community, but the economic condition is often such that hardly anyone is in a position to take advantage of your discovery. This cannot fail to be very disheartening to yourselves, to the public which is looking for material advancement at your hands, and to the Governments to whom we have to look for increased support. If the existing economic difficulties were insuperable, there would be little use in railing against them; but it is because I believe that they can be overcome and that a situation can be created in which the practical value of your labours can be greatly increased, that I venture to address you on the subject.

Stated in its briefest possible form, my proposition is this. In farming there are two fundamental units, the farm and the farmer. For agricultural progress it is necessary that the farm should be a fixed and permanent unit, so that it may admit of permanent improvement and adequate development, and that the farmer should be a fluid and moveable unit, so that the right men may get to the right places. Speaking generally we find, to our misfortune, that in India the exact reverse is the case, that the farm on the one hand is subject to a continuous series of economic earthquakes, and that the farmer on the other hand is fixed and rooted.

To turn first to the farm. So much has been said during the last few years on the subject of the subdivision and fragmentation of holdings, and the evil has been so generally recognized that I do not propose to go into the matter in any detail. No orderly development, no effective improvement can take place in a holding which is the wrong size and shape and which has no stability. The fact that this is true not only in theory but also in practice can be verified by anyone who will take the trouble to do so. Not only is the land totally undeveloped, as development is known in other countries, but the idea of progressive development is hardly understood by the landowners. To develop and improve a permanent 10 or 20 acre farm is an intelligible proposition; but to develop and improve a 10 or 20 acre farm which must in the near future be split up and fragmented is not an intelligible proposition to anyone; and since this is the proposition which confronts the Indian farmer it is not surprising that he does not consider it seriously. In this way a low standard is set of agricultural methods and of agricultural results, a serious obstruction to progress is presented, and there arises a generally uneconomic situation which tends to become worse rather than better.

Now let us turn to the farmer. The farmer owns his small and fluctuating area of land, it may be 15 acres of land in three plots in one generation, and 5 acres in six plots in the next generation. The point is that the farmer is fixed and permanent. His farm may fly into fragments and grow steadily smaller, but, generally speaking, he himself persists, whether he be a good, bad or indifferent farmer. In highly individualistic and competitive countries, efficiency is secured largely by the elimination of the unfit, who are squeezed out of the race by keen competition coupled by a high standard of living. This law is in constant operation in England, and there have been periods of agricultural depression there, when unprogressive farmers have been ruined and squeezed out wholesale, while on some kinds of soil it is recognized that a bad farmer cannot hope, even in prosperous times, to survive many seasons. In rural India, however, the competition is less keen, the standard of living lower, and an easygoing tolerance, combined with an elastic joint-family system, helps to tide the less effective members over their difficulties and to keep them in their places to the obstruction of the more effective members of the community. It is by no means contended that there are no good farmers, nor can it be expected anywhere that all farmers will reach a high degree of excellence; all that is suggested is that, owing to the causes mentioned above, the proportion of bad and indifferent farmers is unduly large. And after all it is this proportion which counts; for while we would term a country backward in agriculture in which only 10% of the farmers were good farmers, we would be able to class it as advanced in agriculture if 50% of the farmers were advanced and progressive.

We may then sum up the situation thus—

The majority of the farms are of the wrong size and the wrong shape: they are not permanent units and are not susceptible of orderly and adequate improvement. The majority of the farmers are deficient in skill, industry and energy, and balance a low standard of endeavour by a low standard of living.

These are the fundamental obstructions to agricultural progress to which I have to refer. The question is how we are to overcome them. It is clear that what we have to do is to endeavour to create and maintain suitably sized and suitably situated holdings which will admit of adequate development, and to arrange that there shall be nothing to prevent these economic units from passing by natural laws into the hands of the most progressive farmers who will be in a position to make the best use of them. If we can do this we can trust to the natural fertility of the soil and the natural industry of the farmers to secure the progress which we desire, aided by the scientific investigations which have been made and which will be made in future. But until we can do this we shall not secure anything like the full results that we look for from our natural advantages or from our scientific labours.

Now what is it that prevents us from taking action of the nature indicated? Whenever any remedial action of this nature is suggested it is always urged that the people have not asked for such action and do not want it, that such action would be opposed to their religion and to their sentiments, and that a shuffle of farms and of farmers would constitute a political danger. These aspects of the question must, of course, be carefully considered. This is a country where religious and sentimental ideals count for much, where political dangers must be given due weight. But there is also a persistent demand on the part of a section of the population for material progress. We have come to the parting of the ways, and India must decide which road she wishes to take. You may set up a sentimental ideal, an aesthetic ideal, an ideal of voluntary poverty, or an ideal of political caution. Such ideals are quite intelligible. The trouble is that to a large extent they are not compatible with the ideal of material progress. All that I say is this—if the former ideals are chosen to the exclusion of the latter let us stop all talk of rapid material progress; for we shall have deliberately refused to take the first steps that lead to it.

The fragmentation of holdings as it affects the introduction of agricultural improvements.—*By* B. C. Burt.

It is claimed that though the question of the un-economic holding is complex, and progress necessarily must be gradual and follow general economic development, there is opportunity for immediate steps to discourage fragmentation of holdings. Two instances are given of the way in which the fragmentation of holdings imposes a definite limit on the introduction of agricultural improvements. It is considered that in *zemindari* provinces changes in tenancy law are possible and desirable which would make the formation of compact holdings reasonably easy.

The prevention of soil erosion on tea estates in Southern India.—*By* R. D. Anstead.

At the Meeting of the Board of Agriculture in India held at Pusa in 1916, the subject of soil erosion was discussed, and it was resolved to

bring to the notice of planters the fact that the serious losses due to soil erosion in the planting districts which have taken place in the past, are, to a large extent, preventable.

In Java soil erosion is prevented by terracing the land before it is planted. In Southern India the problem presented is to stop erosion in old established tea, and the paper describes two methods of doing this in a practical and economic way, which have proved successful and have been widely adopted.

The first is gradually to build up terraces by means of burying prunings in trenches dug along the contours of the slopes, leaving the butts of the prunings projecting 6 to 8 inches from the soil. Weeding and plucking are then done along the contours and at successive prunings the terraces thus formed are improved and others made.

The second method is to stop all forking and clean weeding on steep slopes and to keep these permanently covered with a crop of selected weeds, legumes for preference. Such a crop is established by teaching the weeding coolies to leave the weed chosen, and remove all others.

The best plant so far found for the purpose is *Cassia mimosoides*, L. *Parochetus communis*, Hamil. has also been used.

When these legumes cannot be established use is made of other weeds which grow easily, and large areas are now under *Oxalis corniculata*, L., which has proved an excellent plant for the purpose and has done no harm to the tea.

Any weed is considered better than none, and use has been made of the following :—*Cotula australis*, Hook. f. ; *Cardamine hirsuta*, L. ; *Galinsoga parviflora*, Cav. ; *Laurenberghia hirsuta*, L.

This use of weeds has effectively stopped what is known in Travancore as "dry wash," a slipping of the loose textured soil in the hot weather.

Note on land drainage in irrigated tracts of the Bombay Deccan.—*By* C. C. Inglis.

Just as the conditions which determine irrigation practice in the Bombay Deccan differ in almost every essential from those of Northern India, so the conditions which affect the question of land drainage are also essentially different.

In the Bombay Deccan :—

(1) The damage is entirely due to the canals,
(2) Sodium sulphate is the chief salt,
(3) Substrata vary excessively and abruptly, and
(4) Groundfall is very great (about 1 in 150).

Each drainage may be looked on as a deep valley once denuded of soil and later filled up with colluvial silt.

There are five distinct types of strata :—

(1) Soil—impermeable when wet,
(2) Upper subsoil—impermeable,
(3) Lower subsoil—moderately permeable,
(4) Hard substratum—very permeable, often fissured, and
(5) Fissured rock—slightly to very permeable ;

and for our purpose these should be looked on as three layers of permeability :—

(1) An upper impermeable layer,
(2) A moderately permeable middle layer,
(3) A very permeable hard substratum.

At the top of a ridge the soil covering is red in colour and very thin, and lies directly on the very permeable substratum: down the sides of the ridges the soil deepens both in colour and depth, and a yellow-red impermeable subsoil intervenes; lower down the ridge this is directly underlaid by lime kankar, and lower down still massive kankar is found.

With such a series, and bearing in mind the high groundfall, it will be realized that large quantities of water will pass into and through the high permeable substratum and under the impermeable layer into the valleys, and will pass through into any deep nala or river which cuts the permeable layer. On the other hand, if the permeable layer is not cut, or is of insufficient thickness to get rid of the accumulated water, artesian conditions arise, and the excess water which cannot drain away is forced through the shallower portions of the surface layer and up into the deeper portions until the evaporation carries off the excess.

If we bore a hole in a salt area we do not find subsoil water near the surface, and it is not till we pierce the moderately permeable subsoil layer at about 5 to 10 feet that water rushes in with a hissing noise.

The permeability of the permeable layer is measured by the rate of recuperation in the bore holes by the formula:—

$$\frac{K}{A} = \frac{1}{T} \log \frac{H}{h}$$

where K = Coefficient.
T = Time in hours.
H = Full head of depression.
h = Head of depression after T hours.

Unfortunately this only gives us a measure of the permeability of the layer, and does not necessarily show that it is a main avenue of drainage. The main supply may come through fissures at a great depth, and possibly through rock.

The essential point is that we are dealing with a pressure; hence the very great difficulty of the problem. The permeable subsoil should not be looked on as an avenue for drainage but merely as a medium through which the deep subsoil-pressure is diffused.

What we have to do, therefore, is to find out the natural deep drainages of the original denuded valleys and open them out down to the deep permeable stratum.

Very frequently existing nalas do not follow the natural drainages, and depressions seldom do.

Where the permeable stratum is at such a depth that a drain reaching down to it is out of the question, much can still be done by driving down bore holes into this stratum, when the water rises under pressure and can be carried away in a pipe drain.

The frequent failure of a large proportion of the rice crop in Chota Nagpur.—*By* A. C. Dobbs.

The soil of the Chota Nagpur plateaus rests for the most part on solid gneissic rocks, and the subsoil water is derived from the local rainfall. The paddy crop on the plateaus suffers peculiarly from an early cessation of the monsoon, because the gradients are steep and $\frac{3}{5}$ of the terraced area lies above the line along which the subsoil water emerges from the sides of the bluffs and ridges at the end of a normal monsoon, and these terraces therefore dry to the point of cracking about a fortnight after the last shower. The crop is therefore safe only on the concave surfaces of the valleys, below the water line.

There are very few tanks to protect the crop, and the total paddy harvested, which in a normal year represents $\frac{3}{4}$ of the total value of the crops of the Ranchi District, is reduced by at least $\frac{1}{3}$ if no rain falls after the middle of September, however favourable the season may otherwise have been.

There are practically no exports of food in a normal season and scarcity has prevailed in great parts of the District in four years since 1896, exclusive of the present year.

Statistics of the rise and fall of the water in a well on the Ranchi Farm show that the rise of the subsoil water in the monsoon up to a certain point may amount to five or six times the contemporary rainfall measured in inches, whereas the fall at the end of the monsoon is about 38 inches in a month.

The safety of the paddy crop, depending on the subsoil water, could be insured if the subsoil water could be maintained at a sufficiently high level by holding up water in tanks placed in echelon round the perimeter of each bluff above the highest terraces. Experience indicates that such tanks, filled intermittently by showers and leaking continuously into the surrounding subsoil, need only hold about 5 ft. of water at one time in order to carry the crop over three or four weeks of drought. Tanks, 100 ft. wide, the capacity of which could be increased at a low cost, if necessary, would be sufficient in the first instance, and are economically justifiable. They would be connected in series and each would have an emergency outlet into the paddy field immediately behind it and below the previous tank in the series.

If the rain water that now runs off the surface could ultimately be brought under general control in this way, 1¼ million horsepower could be made available for six months in the year, on a conservative estimate, from the Ranchi District (7,000 sq. miles) alone.

The importance of the development of the dairy industry in India.—*By* W. SMITH.

Development of dairying industry in India is important from an agricultural point of view because

(1) Only by this means can the greatest of all agricultural problems in India—the cattle-breeding problem—be placed on a sound economic basis.

(2) It particularly lends itself to development on co-operative lines. Agricultural co-operation has been the business salvation of the small holder in many countries; it should be so in India.

(3) The solving of the cattle-breeding problem on dairying lines must at the same time enormously increase the productivity of the land, as the farmer will breed, rear and feed his own animal on his own land, and its manure will be available to renew the fertility of the soil year by year.

From a general or national point of view it is important because cheap and pure dairy produce is essential to the health of the community; they cannot get it now, and nothing but the development of dairying as a national industry will give it to them.

The improvement of Indian dairy cattle.—*By* A. K. YEGNANARAYANA IYER.

A brief statement of the present condition of the dairy industry is given, and the recommendations towards improving it are reviewed. The improvement of the milking quality of dairy cows (1) by confining operations to the indigenous breeds and grading them up by selection, and (2) by the introduction of foreign blood by cross breeding with Ayrshire or other British or Australian breeds, is described. The milking quality is regarded as a Mendelian "dominant" and inferences drawn as to the limitations of this method of breeding. The use of only pure bred sires is insisted on, as the only means of guarding against disappointment in the performance of the cows of crossbred progeny.

The use of poppy seed cake as a cattle food and its effect on yield of milk and composition of butter fat.—*By* H. E. ANNETT and J. SEN.

The seed forms a valuable secondary crop to the cultivator of opium poppy. The bulk of the poppy seed produced in India used to be exported, but owing to the war there had been a falling off in the export. At the same time the internal demand for the seed is not likely to increase sufficiently to use up the whole production.

But there seems to be little difficulty in finding a market for poppy seed oil in India. In this connection the question of the use of the poppy seed cake as a food-stuff has arisen. Experiments were therefore undertaken on this subject.

Substitution of poppy cake for mustard cake does not seem to have influenced either the yield of milk, its percentage of fat or the composition of the butter fat. The experiments were carried out on one cow and two buffaloes.

The animals readily ate poppy cake and seemed to flourish equally well on poppy cake or on mustard cake. The reputed ill-effects of poppy cake in producing drowsiness and watery milk were not observed.

During the course of the work it was noted that weather conditions seemed to influence, to a certain extent, the composition of butter fat. This may be due to indirect effects (e.g. a rush of green food after rain).

Studies in the chemistry of sugar-cane.—*By* B. VISWANATH.

A method has been devised for extracting small quantities of juice from sugar-cane, without appreciable injury to the cane, by means of a modified form of hypodermic needle.

The juice so obtained can be examined for its total solids content by means of the Abbe refractometer. The refractive indices of sucrose, glucose and substances found in sugar-cane, are found to be the same.

A number of canes nearing maturity as judged by the eye and experience have been examined internode after internode from bottom to top. The results show that the point of maximum sugar content is frequently close to the highest dead leaf joint and that a sudden fall in sugar content occurs above the dead leaf joint. The point of maximum sugar content could not be definitely located at any particular internode but is never above the dead leaf joint.

This variation is thought to be due to different degrees of ripeness in the canes examined. A number of *young* canes have been tested joint by joint month after month, and it has been found that when the cane is *young* the maximum sugar content is at the basal joints and gradually this moves upwards to the highest dead leaf joint as the cane matures.

The function of the leaf being a physiological one, it was thought that a joint would have accumulated its sugar to its fullest capacity by the time the leaf is dead and cast. This is found not to be the case. A distinct increase of sugars occurs in an internode even after the death of the leaf.

Two possible explanations for the increase of sugar are offered. They are (1) the influx of sugars from above as the cane grows, (2) the elaboration of sugars subsequent to the death of the leaf from the material already gathered and converted into carbohydrates of higher molecular weight than sugars, such as cellulose, starch, gums and the like.

Starch and diastase have been recognized in the younger parts of the cane, but none are found in the older joints.

It has been shown, on the authority of existing literature on the physiology of sugar-cane, that the storage of cane sugar in the sugar-cane is not such a simple process as the polymerisation of reducing sugars into sucrose, and that the second explanation seems more reasonable.

The necessity for further investigation into the mode of formation of cane sugar in the cane is indicated.

The effects of salinity on the growth and composition of sugar-cane varieties.—*By* R. KRISHNAMURTI RAO.

During 1913 in a portion of Block II (Field Nos. 12, 13 and 3) of the newly-acquired Cane-breeding Station, Coimbatore, many thick and thin cane varieties and some Madras seedlings were for the first time planted. Most of the thick cane varieties died and a few that came up were very unhealthy. Thin North Indian varieties came up better but not to the standard expected. Madras seedlings fared no better. To study the causes for this unsatisfactory result of canegrowth, field No. 3 as representing Block II was chosen, and on it year after year some cane varieties and seedlings were grown under the same conditions as existed before. For the purpose of comparison, another field in Block I, where cane growth is better and more satisfactory, was selected and half a dozen varieties that were doing well in Block II were planted.

A comparison of the analyses of soil and sub-soil layers and also of the well waters of the above two blocks showed that Block I contained much less chlorine in soil and sub-soil layers than Block II; the well water of Block I contained only 33 parts of sodium chloride in 100,000 parts of water, whereas the well waters of Block II (well No. 3) contained as much as 189 parts of sodium chloride. This large excess of sodium chloride in the irrigation water was reflected in the composition of cane juices obtained from Block II (field No. 3) which showed a large excess of chlorine and potash.

As excess of chlorine was found to be accompanied by excess of potash, though not in any definite proportion, a determination of either was considered sufficient to get an idea of the quantity of the other. The determination of potash is not easy and takes much time, and so choice fell on chlorine. Even in this, the usual method of determining chlorine in juices—evaporation to dryness, ignition and titration of the water extract with silver nitrate solution—was not sufficiently rapid, and so another method of directly determining chlorine in juices using lime water and alumina cream, which gives satisfactory results, was adopted.

When the nature of varieties that have from the year 1914 till now come up well and of those that have not done well in Block II is analysed, it is found that, generally speaking, thin, hard, low juice varieties do fairly well and that thick, soft, high juice varieties have practically no chance. When the average chlorine contents of juices of North Indian cane varieties grown under saline conditions of Block II and of the same varieties under sweet water conditions of Block I were compared, it was found that in Block II 0·32 of chlorine was the average obtained, whereas in Block I it was only 0·15. It was also found that different varieties grown on the same plot and under the same conditions, contain somewhat different amounts of chlorine.

The effect of chlorine on the quality of juices obtained under saline and non-saline conditions was then compared. It was found that the percentage of glucose, sucrose, purity, etc., of varieties grown on Block II (saline) were less than that obtained from the same varieties on Block I. Juices containing large amounts of soluble salts and low glucose have been found to give low amounts of crystallisable sugar. Possibly due to this the jaggeries made at the Cane-breeding Station from North Indian thin canes do not set well and have a tendency to run to liquid when kept long.

Having shown excess of chlorine in cane juices to be the chief cause for the poor growth of canes, for low sucrose, glucose and purity contents of juices and also for the inferior jaggery obtained, it is suggested that chlorine determinations of juices would give one an indication of the relative qualities of the juices examined and of the nature of jaggeries one is likely to get from such juices.

Some new factors affecting the keeping quality of gul or crude sugar.—*By* T. S. Swadi.

Hardness is all-important for storage of gul during the monsoon.

The factor hitherto supposed chiefly to affect the hardness is the ripeness of the cane.

The new factors which are equally or even more important, as observed by the author in the Gokak-Hukeri tract, emanate from the presence of alkaline salts in the water used for irrigation and in the soil producing the gul. These salts enter into the composition of the gul and adversely affect the hardness and are found in greater proportions in brackish water and some kinds of soils.

There is also a belief in the locality to the above effect though rather vague.

Before undertaking the investigation attempts were made to improve the defect in the gul, peculiar to the conditions stated, on the lines hitherto known on the subject, but little success was attained by the author.

There is ample proof to show that alkaline salts exist in greater or smaller proportions in gul.

For the reasons and proofs given, the author is led to the conclusion that water and soils have an important bearing on the question.

The remarks of the Agricultural Chemist on the samples sent for analysis are fairly corroborative of the author's observations.

A study of the conditions under which water of tidal saline creeks is utilized for crop production in Konkan.—*By* V. G. Gokhale.

A practice of using the water of saline tidal creeks has come to the notice of the writer, the results of whose study of the conditions under which it is done are embodied in the paper. After a brief description of the tract under observation, especially with respect to its creeks and creek side lands, the several factors which have been found to determine the successful cultivation of certain crops with saline water are discussed.

The figures of analysis of the samples of water taken at each watering given to a crop of Brinjal cultivated with the exclusive use of water from one of the large tidal creeks have been given; these show that in the last 8 to 10 mile section at the sweet water end of the creek the waters even under the high tides are quite sweet during the monsoon, and acquire only a very slight salinity till the end of December, if the monsoon is over by the end of October; later on, during the months of January and February, the salinity increases to nearly 850 parts of total salts per 100,000 parts, out of which 650 parts are sodium chloride—a degree of concentration which might have been considered unfit to sustain any agricultural crops; by the end of February the creek waters become too saline, approaching a total salt content of about 2½ per cent. or nearly three-fourths of the salinity of the average sea-water, and are not used for any crops thereafter.

From a survey of the several large and important creeks as represented by the four districts of the Konkan, it is to be observed that it is only to the last 8 to 10 mile section at the sweet water end of a 25 to 35 mile length of a tidal creek that the cultivation of certain crops is found to be confined, the reasons being that creek waters in these sections are said to be less saline than in the lower sections towards the sea, and it is in these

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sections that banks, having deep and fertile soil and sufficiently high not to be submerged by high tides, but not too high to preclude cheap water lifting, are found.

The crops that are seen successfully cultivated under such conditions are brinjal (Solamem melongena) and chillies (Capsicum frules cens), brinjals being the commoner of the two, chillies being supposed to be less resistant to salt than brinjals. Castor (Ricinus communis), sweet-potato (Ipomea batatas) and maize (zea mays) are also occasionally found grown on the borders or as a sprinkling in the main crops of brinjal and chillies. No separate varieties specially adapted for saline water are recognized, the usual sweet water varieties being cultivated under salt-water conditions. Sowing is done in the middle of October, and the method of cultivation is generally similiar to that with sweet water; farm-yard manure is the only manure given, if at all, and where available; but the same place does not carry the cultivation for more than one to three years continuously according to the nearer or farther situation from the sea, as the soil is supposed to get "salt sick."

Saline water of the creek is the only water given from the time of planting to the end of February, at shorter intervals of a day or so for the first month and thereafter at longer intervals of four to eight days according to the retentive nature of the soil. After February the water is recognized to get too saline to be used and no watering is done, but the plants have to depend on the residual soil moisture on which they survive and continue to bear till the end of the hot season. Sometimes distinct incrustation of salt is visible on the surface of the field later in the season. It is usually at high tide that watering is done as the rise of the water level reduces the lift or lead; no difference is, however, recognized between low tide and high tide waters; the full moon or the new moon tides, together with those on the two or three succeeding days, are usually avoided as they are believed to contain more saline water.

The quality or the quantity of the outturn of the crops is in no way less than those of the sweet water plantations, but in the case of brinjals the pickings from April onwards are small with small-sized fruit having often an acrid taste.

It has been observed that the possibility of growing certain crops with saline water is yet unknown on the creek sides in the Thana and Kanara districts, where sites with conditions similar to the foregoing description are not wanting; similarly even in the districts of Kolaba and Ratnagiri where the practice is known to some extent, there are still many localities which are not fully exploited; it is such localities that present good scope for the introduction or extension of the practice. Other parts of India and elsewhere, where conditions might be found similarly favourable, but where the practice described in the paper is not known, might benefit by the presentation of the results of the study made in Konkan.

It would also be worth while to try other crops, especially those which, according to present knowledge, are recognized to be more salt resistant, under the conditions herein defined with a view to find out if there are any new and more remunerative crops that can be added to those mentioned in the paper. This would form one of the lines of future study of the subject.

Rate of nitrification of different green manures.—*By* N. V. JOSHI.

It is shown that the rate of nitrification for different green manures is different, varying with the amount of woody tissue and pith and other carbohydrate material, and that the beneficial effect of the green manure is due more to the leaves than to the roots for the following reasons. The nitrogen content of the above ground portion of leguminous plants is about three-fourths to nine-tenths of the total nitrogen of the whole

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plant. The nitrifiability of the leaves also is much higher. It is also shown that starch, glucose, filter paper, straw and sawdust affect the nitrification of oil-cake and ammonium sulphate.

The experimental evolution of *Oryza sativa* var. *plena*, Prain.—*By* B. K. BHIDE.

To all outward appearances, *Oryza sativa*, var. *plena*, Prain, or the double grain paddy of Bengal, looks like an ordinary variety. But it has this peculiarity that nearly every spikelet contains two to five ovaries instead of one, the number of well-developed grains being often only one or two.

At Alibag, in a plot of about 100 plants of an ordinary variety of rice, called Morchuka, the writer found this year that in 8 or 10 plants about 10 per cent. of the spikelets had a tendency to form additional flowering glumes and pales and sometimes ovaries also, these spikelets being often sterile or one grained, though rarely they may produce two grains also. The additional glumes and pales have a tendency to be cut up, variously transformed, or somewhat reduced. It has been suggested that this sport might be the beginning of the evolution of the double grain paddy. Specimens showing the abnormality in different stages have been collected and drawn to illustrate the paper. The writer intends to collect seeds of the strongly sportive plants and to grow several generations from them to see if by selecting from them the suggested expectation will be realized.

Notes on the ring disease of potato.—*By* S. D. NAGPURKAR and H. H. MANN.

Ring disease of potato is a bacterial wilt which is the principal enemy of potato cultivation on the Deccan. The experiments were carried out to see by what means the crop could be infected, and which of these was the dominant cause of the perpetuation of the disease in the field.

The experiments recorded confirm previous results as to the conveyance of the ring disease of potato from crop to crop both through the seed and the soil. They show the extremely infectious character of the disease in that not only the seed, but also every thing which has been in contact with it, even the knife by which affected sets have been cut, is capable of conveying the disease to a healthy tuber and hence to a healthy plant.

The infection does not, however, appear to live long in the soil in a virulent enough condition to affect new plants. After two and a half months the infectiveness was reduced by at least seventy-five per cent. After five to six and a half months the infectiveness of the soil for new potato plants had disappeared. It would thus appear that if land is kept free from potato plants, or other plants capable of carrying the disease, for six months the danger of infection through the soil is very small. As six months or more is usually allowed to elapse between crops on the same land in the Deccan it would appear that the danger of infection through the soil under Deccan conditions is small, if the diseased plants are carefully removed during the growth of each crop. This agrees with practical experience and enables attention to be focussed on the provision of disease-free seed as the main line of attack on this very fatal disease.

Methods of planting sugar-cane and position of seed in ground.—*By* M. L. KULKARNI.

Results of experiments of the single-eye method of planting sugar-cane sets, with the eye planted upwards, are given in the present paper, as promised last year, and these figures are compared with other improved methods. With the advantages in the single-eye method its defects are also shown, and further experiments with alterations to remove the defects, as suggested to the writer, were conducted during the current year and the altered method explained.

The experiments tried last year in pots, with different kinds of seeds in different positions, were tried in a few rows of each in the field with the same results as obtained in pots last year. The root system of plants germinating from seeds in different positions (especially of cotton) was examined and found to be the cause of unevenness of plants in different positions.

Some foreign insect pests which we do not want in India.—*By* K. Ramakrishna Iyer.

In these days of frequent and rapid communication between countries even far apart, agricultural products of various kinds, such as fresh fruits of all sorts, bulbs, roots, tubers and nursery stock of various kinds are transported with great ease. This facility for mutual transport, however, helps insects of different kinds found on these fresh products to distribute themselves into new homes and often become serious pests. From an agricultural point of view this is undesirable. It is, therefore, necessary that, when such products are likely to carry pests, a thorough inspection should be made at the place of entry and the pest destroyed before the commodity is admitted into the country. This paper gives a brief list of some of the most important foreign insects which we would do well to know something about, and which we should try our best to keep out. The most important of those mentioned are the San Jose scale, the cotton boll weevil, the Codlin moth, the Mediterranean fruit fly and the grape Phylloxera.

Notes on a *Moringa* stem borer.—*By* T. V. Subramania Iyer.

The paper deals with the life-history of a longicorn beetle boring on the *moringa* plant (*Moringa pterygosperma*). The insect has not yet been identified and has been sent to experts for identification. A stray grub was one day seen boring inside a *moringa* twig and the adult when reared out at the insectary was found to be this beetle. Afterwards a pair of these beetles were caught during copulation and made to lay eggs in captivity and the life-history was completely studied. The insect is not a serious pest but it is seen occasionally scraping away the bark of the plant when an adult and boring in *moringa* twigs during its larval stage.

The biological determination of the relative availability of different nitrogenous organic manures in black cotton soil.—*By* F. J. Plymen *and* D. V. Bal.

1. The relative availabilities of the common oil cakes used as manure have been determined by considering the rate at which the nitrogen they contain undergoes bacterial transformation.

2. The soil used in the experiments was the common black cotton soil of the Deccan.

3. Excluding oil free tili cake, karanja and cotton cakes appear by far to be the most quickly available and castor cake is not much inferior to them.

4. Tili cake is not quite so active, although the nitrogen nitrified ultimately, compares favourably with that of other cakes.

5. Of the various manures used in this experiment with the exception of mahua cake, sarson cake is the slowest so far as its nitrifiability in black cotton soil is concerned.

6. The nitrogen in mahua cake is neither ammonified nor nitrified to any appreciable extent during a period of 8 weeks.

Earcockle in the Punjab.—*By* Dr. Milne.

The cause of the disease is Tylenchus scandens, a nematode worm. It enters the wheat ovaries and produces galls instead of wheat grains. A brief outline of the life-history of the disease in wheat plots at Lyallpur is given. Wheats are sown here in November and they ripen in April. The experimental wheats were sown mixed with galls on irrigated lands at the usual wheat sowing time. The worms were met with regularly on the plants in January. By the end of January they were met with in abundance in the ligules and young buds, and were very active. Where many were found in the buds, the leaves were distorted, and in some cases a slimy yellow substance full of bacteria appeared on the leaves. We have never met with this slimy bacterial substance except on plants affected by earcockle. Lightly attacked plants showed little sign of the disease unless minutely examined. The worms are carried up with the wheat head as it comes out of the ear, collect in the ovary and suck the juices which should go to form the wheat grain. Egg-laying is common by the middle of March. Hatching starts by the end of March and ends in early April, and the galls turn from green to brown at that time.

Thousands of young worms may be found in one gall. The galls dry up and the worms become quiescent. They may remain in this state and retain vitality for years.

The disease is found practically all over the province, and cases have been met with where it has destroyed 50 to 80% of the crop in a field. It apparently has caused a loss of over 2¼ lakhs of rupees per annum in Muzaffargarh district alone in recent years. Experiments at Lyallpur indicate that although the worms retain their vitality for years when the galls are stored with the wheat grains they cannot usually do so when lying in fields either fallowed between harvest and the following sowing time, or cultivated during that period, therefore that the galls which produce diseased crops usually get into the fields annually with the seed grain and consequently that farmers can save the loss caused by the disease at practically no expense to themselves, in a single year, and without upsetting their rotations, by simply sowing clean seed grain.

No types of wheat grown in the Punjab are immune from the disease. Barley is affected by the same worm.

The galls can be best separated from the grain by a combination of winnowing and sifting.

The general belief among farmers is that the disease is due to bad winds, untimely rains, etc., and that it is hopeless attempting to combat the disease. I think we should begin this work by selecting a few very seriously affected farms and sowing alternate strips of land with cleaned wheat grain and with the farmers' ordinary seed grain respectively, in fields which have been badly affected in the previous year; then take farmers round to see the differences in the crop about harvest time. We have already had very good results with this method of convincing farmers of the possibility of getting rid of the disease. Later we can enlist the services of leading farmers, members of District Boards and Co-operative Credit Societies in the work.

Earcockle differs from all other wheat diseases in the Punjab in that cases have occurred in which individual farmers have lost most of their crop for several years in succession by its ravages. This fact marks it out as by far the most deadly wheat disease in the province.

I should be glad of any information regarding its occurrence, etc., in other parts of India.

Drainage and crop production in India.—*By* A. Howard *and* G. L. C. Howard.

One of the factors which limits crop production over large areas of the monsoon fed area of India is defective drainage. In the plains of

India this arises either from surface waterlogging or by the limitation of percolation brought about by the rise of the ground water. The effect of this on growth and root development is discussed and some recent results with Java indigo are described in detail. The wider aspects of drainage involve the employment of engineers and the construction of drainage maps.

Some observations of the life-history of an erotylid breeding in Italian millet.—*By* P. V. Isaac.

Section of Physics and Mathematics.

President:—Dr. D. N. Mallik, B.A., F.R.S.E.

Presidential Address.

Recent Advances in Physics and Mathematics.

I beg to thank you for the honour you have done me by asking me to preside on this occasion.

When it was intimated to me that the Committee had been pleased to ask me to preside over the Physical and Mathematical Section of the Indian Science Congress, I felt that the only way in which I could show my gratitude for the honour was, while thanking you for it most heartily, by presenting to you a brief report on the recent advances in these subjects, so that all who are interested in them, whatever their actual avocations may be, may have a bird's-eye view of the entire field. I knew that the task would not be an easy one. But I had not realized that it would be *such* a difficult—practically an impossible task.

In seeking to speak on recent advances, I naturally referred to the "recent advances" of fifty years ago, detailed with his usual perspicacity by the late Professor Tait. Unfortunately, however, the circumstances are so entirely different that the lead, so authoritatively given cannot, in the present day, be followed for more than a few steps. It was a comfortable position, then, for one was clear as to what had been achieved and one had a cheerful belief that the position was unassailable. It is no longer so now. The present position can only be described as *bewildering*. Physicists, at the time of Tait's expositions, had an idea that they knew all about force, matter, energy, atoms and molecules and as much as it was possible to know of time and space. They had also a perfect faith in mathematical symbols, so that the calculus was to them an unfailing instrument, if only it could be somehow brought to bear on physical problems, duly suggested however by experiments. All that is changed now. It seems in the present day that the learning and teaching of physical science is almost a work of super-erogation,—to judge at least, from the manner in which ridicule is often heaped on "text books" and "present-day teaching." Things are, however, not so bad as would at first sight appear. Stated broadly, the present confusion reduces only to this—namely, that although we do not know all about anything in particular, we know a great deal more about many things than we did before, and we have at any rate now a clearer apprehension. of the nature of the problem that awaits solution, than in Tait's time. The recent advances, accordingly, are real, even although every physical concept, nay every notion that was formerly regarded as fundamental has had to be re-discussed and no final pronouncement is as yet possible on their true nature.

Take *force*, for instance. Its objectivity was implicitly acknowledged, not merely in text books but scientific discussions as well, and was freely read into Newton's Laws of Motion, till Mach and his school emphatically repudiated its claim to any such position. Tait, no doubt, in his recent advances, had defined it simply as a *rate*,—space-rate of change of energy,—but he was induced to appeal to muscular sense for its illustration. To Professor Karl Pearson, however, it was an arbitrary conceptual measure of motion without any perceptual equivalent. But then, all physical laws, so-called, are really, to quote Karl Pearson again, but conceptual shorthands for the routine of our perception, so that an inquiry into the intimate nature of force which is a legitimate subject of discussion would but lead, even if it be successful, to a conceptual model. From this point of view, Newton's Laws are non-committal. They supply a definition of force, provide a means of measuring forces, thus defined and indicate (in the 3rd law) how they come into operation, but omit to postulate anything further as to their intimate nature. It is now recognized, however, that this is a proper subject of investigation in Physics, and that in our investigations it is legitimate to proceed on the postulate of physical existence of forces. "To say" (says Larmor) "that force is a mere figment of the imagination . . . . . is to assume a scientific attitude that is appropriate for an intelligence that surveys the totality of things." And accordingly, we find that the latest form of the Electron Theory, for instance, proceeds on the admission, not that we know what force is but that we can identify and *thus* take cognisance of it, objectively.

We have, thus, an indication of how our scientific ideas are undergoing re-adjustments, and there are many others. Some of these we shall have to refer to in due course. Broadly stated, however, the great general problem of modern Physics, as I conceive it, is the nature of the electro-magnetic field, and the processes associated with it. This appears to be the meaning of the following extract from Sir Joseph Larmor.

Referring to the title of his paper read at the Congress of Mathematicians at Cambridge in 1912, on the "Dynamics of Radiation," he says:—

"The subject of this title is co-extensive with the whole range of the physics of imponderable agencies. For, if it is correct to say with Maxwell that all radiation is an electro-dynamic phenomenon, it is equally correct to say with him that electro-dynamic relations between material bodies are established by the operation, on the molecules of those bodies, of fields of force which are propagated in free space as radiation and in accordance with the laws of radiation from one body to the other."

As the simplest illustration of an electro-magnetic field, we may take the region in the neighbourhood of a wire carrying current (as well as inside it). There is *flow of electricity*, inside the wire, attendant generation of heat, and magnetic effects, essentially associated with it. And even without knowing the intimate nature of *electricity*, flow of electricity, magnetism, and magnetic effects, we may well call this an electro-magnetic field.

Another, a less simple one, would be the field due to a condenser, charged in the usual way by a frictional machine or a voltaic cell, ... in particular, the dielectric region between the two conducting surfaces. The sum total of effect is to *statically charge* the condenser, but when the intimate nature of the phenomenon is analyzed, one is constrained to admit that there is a "movement" across the dielectric, in the same sense as there is a movement in a wire carrying current. For, if the difference of potential between the plates is sufficiently increased, there is set up a measurable current with or without luminosity (an electric discharge, silent or luminous). Across the dielectric, therefore, one may describe the effect as that of electric displacement, completing the electric circuit, as in an ordinary wire circuit. It follows, accordingly, that the static effect observed is of the nature of a convective equilibrium, so that a charged condenser is to be regarded also on this view as giving rise to an electro-magnetic field.

And if this is granted, there would be no reason for denying that any so-called *electrostatic* field is also in reality an electro-magnetic field, even though no direct magnetic effect may be detectable in it.

For another illustration, we may again take a condenser, charge or discharge it, at intervals. It can be directly proved that the discharge is oscillatory, and the period of oscillation can be calculated Now, as we know, by suitable arrangements, the effect of this oscillatory discharge can be detected at a distance, and since an electric discharge means movement, an oscillatory discharge must be oscillatory movement, which is thus taken up by the field or the medium and induces oscillatory movement, thousands of miles away, the practical realization of which represents the latest triumphs of wireless telegraphy.

As to the properties of the field, there is one fact that is certainly known. The medium does take part in the transference of energy, and so does the luminiferous medium through which the vibratory energy of which light is known to consist is transmitted from the source to the eye of the observer. Are the two mediums identical ? Since the velocity of propagation of an electromagnetic disturbance (of which an oscillatory discharge is the source) is equal to the velocity of propagation, and high frequency electric oscillations are attended with luminosity of neighbouring conductors, only one answer to this question is now possible, namely that in the affirmative. But this determination came later, as the result of Hertz's experiments, undertaken in an attempted verification of the theoretical provisions of Maxwell. To these, therefore, a brief reference will be necessary.

Briefly stated Maxwell's theory amounted to this. The electromotive intensity at any point of the field produces a forced state in the medium which Maxwell called electric displacement. Now, if electromotive intensity is assumed to be proportional to electric displacement, the electrostatic energy of the field can be written down as a volume integral, in terms of electric displacements. The electromagnetic energy can, in the same way, be expressed as a volume integral, in terms of magnetic induction. Assuming further, that the former is potential energy and the latter kinetic, energy, by the application of a general dynamical principle, called the Principle of Least Action, the equations of motion of an electric disturbance can be obtained and these are found to be appropriate to transverse wave propagation.

Maxwell was thus led to conclude that the electromagnetic field and the luminiferous medium are " identical." His definite reason for doing so is so explicit that it may well be quoted here, especially as this fundamental position is now being reviewed, in terms of the latest theories.

" To fill all space," said Maxwell, " with a new medium, whenever any new phenomenon is to be explained is by no means philosophical; but if the study of the different branches has independently suggested the idea of a medium and, if the properties which must be attributed to the medium, in order to account for the electromagnetic phenomena are of the same kind, as those which we attribute to the luminiferous medium, in order to account for the phenomenon of light, the evidence for the physical existence of the medium will be considerably strengthened." And this evidence appeared to be complete when direct proof was forthcoming, as the result of Hertz's researches. But as I have just indicated, the new theory of relativity has led to a reconsideration of the entire subject, which it will be desirable for us to examine briefly, in due course.

It should be noted here that there is an exact concordance between the simple electromagnetic theory of Maxwell and a form of the elastic-solid-theory due to MacCullagh, if we agree to identify magnetic force with the velocity of the medium (due to the action of the electromagnetic forces) and electric displacement with molecular rotation. This enables us to interpret in a formal manner—but, perhaps, only in a formal manner—the nature of the electric quantities involved. There is one suggestion supplied by this concordance, however, which may be of far-reaching importance. In order that MacCullagh's theory should be at all tenable, it is necessary to admit the existence of a certain amount of intrinsic energy in the medium. This may accordingly be taken to be implied in the electromagnetic theory on Maxwell's scheme, so that the medium postulated therein, cannot be that of a *stagnant* ether.

A further point emerges from this concordance that is also worthy of note. It is assumed in Maxwell's theory that the electrostatic energy is potential and electromagnetic energy is kinetic. On the above concordance, therefore, the potential energy is due to molecular rotation. And if, further, we agree that this molecular rotation corresponds to a vertical spin, we must be disposed to agree that the so-called potential energy is also in reality kinetic.

Thus, when a body is charged, a subtle ethereal motion must be conceived to be induced in the field, surrounding it, (and inside it), and the corresponding kinetic energy would then account, partly or wholly, for the static energy—so-called —of the electrostatic field.

Again, when radiation is propagated through the (ethereal) medium, the propagation is associated with convected momentum of the field, which accounts for the entire energy of this radiation. It is this momentum which seems to appear in Poynting's well-known theory of the flow of total.energy, across the field, in the direction of the flow and also in the *pressure* of radiation, when radiation is received by a slab, absorbing energy.

This would indicate that the entire energy concerned in the propagation of radiation is entirely kinetic and, in this event, the intrinsic energy postulated above must also be entirely kinetic. If this be so, the ethereal medium in free space may prove to be neither *stagnant* nor *immobile*.

It may be noted in passing, as it has been suggested by Larmor and others, that this suggested intrinsic energy may have relation to the propagation of gravitation, in the nature, conceivably, of longitudinal waves, propagated with very high velocities.

At the time Tait wrote his recent advances, the doctrine of energy had been placed on what then appeared to be a firm footing—summarized in the two laws of thermodynamics. But on the ultimate nature of this energy, there was hardly set on foot a single enquiry. It was recognized, no doubt, that the intimate nature of potential energy required investigation, but it was assumed that kinetic energy required none. An attempt to analyse the processes operating in the electromagnetic field has brought this question to the fore. While, on the one hand, application of thermodynamics has suggested the discontinuous nature of energy, on the other, the theory of relativity seems to throw doubt on the objectivity of energy itself. Laying aside these new developments for the present, we observe that all the electromagnetic phenomenon, so far considered, are concerned with movements and a transfer of movements through the medium and magnetic effects associated with them. The questions that are pertinent and have been the subject matter of recent investigations, is what is it that moves in the 'charged' bodies and in the medium, and what properties must be postulated regarding the latter ? We have had, accordingly, the hypotheses of two fluids and one fluid to explain the nature of the charge and the hypothesis of polarization in the medium as a deformation or strain, which Faraday accounted for as being due to the operation of stress, on the analogy of the properties of an elastic solid. This was followed out, as we have seen, to its mathematical conclusions, in Maxwell's theory. Basing his views on the Faraday-Maxwell theory of stress in the medium, Sir O. Lodge briefly answered the first of the questions in his Modern Views of Electricity, by saying that it was the ether. Ether in static stress is according to Sir O. Lodge static electricity, ether in motion is current electricity, ether in vibratory motion is concerned in the propagation of the electrodynamic disturbance which constitutes radiation generally, while ether in vortical spin is magnetism.

This was an interesting way of bringing out the relations between the different aspects of the field which seemed, at the time, wholly justifiable, but since then important modifications have been called for, both on experimental and theoretical grounds. For it was at once seen that the simple theory of Maxwell, modified in some particulars by Hertz, was capable of explaining only the more simple optical phenomenon of ordinary reflection, refraction, and double refraction but could render no satisfactory account of metallic reflection, dispersion and aberration,—those phenomena namely in which the operation of gross matter obviously modified the properties of the field.

Now, it was noted, on experimental grounds, that a unit charge is not a mathematical fiction but a physical entity, possessing inertia (under defined conditions) in the Newtonian sense. This unit charge is of course different from the absolute electrostatic unit, which was, at its inception, a mere matter of definition. It is significant, however, that though the conception of imponderables was foreign to the prevailing scientific belief, Maxwell's pronouncement on the intimate nature of an electric charge, fully recognized the possibility of its materiality. "It appears to me," he said, "that while we derive great advantage from the recognition of the many analogies between electric current and current of a material fluid, there is, as yet, no experimental evidence to show whether the electric current is the current of a material substance or a double current or whether its velocity is great or small." He had, in fact, attempted to measure the inertia of electricity but without success. Evidently, a more refined process was necessary than that which he employed. This has now been accomplished and we now know that the unit charge of electricity is about $4{\cdot}5 \times 10^{-10}$ electrostatic unit, the unit of negative charge, having a mass of about $8{\cdot}8 \times 10^{-28}$ gramme (under the conditions of the experiment for its determination), while the unit of positive charge has a mass, comparable to that of an ordinary material atom.

The postulate of an absolute unit of charge is, in fact, implicitly contained in the statement of Faraday's laws of electrolysis. For during electrolysis, the passage of the same quantity of electricity always decomposes the same number of molecules. In other words, each monovalent atom carries with it, to the anode, the same quantity of negative charge. It is, a priori, evident, therefore, that this is the smallest quantity of electricity that takes part in electrical phenomena and has, therefore, as Helmtolz pointed out in 1880, the characteristics of an atom or absolute unit of electricity. Measurements under this and other conditions have established its identity as an invariable change. And, if we call it the electron, we must conceive an atom showing no electrical properties as the result of combination of one or more electrons with what may fittingly be called a certain number of positive particles. This would then amount to the statement that electrical properties of bodies as well as those of dielectric media are due to the presence of electrons or corpuscles associated with positive particles or atoms of matter (each doublet rapidly moving about each other for equilibrium), the atoms, electrons and positive particles forming systems of various degrees of complexity. And it has been found that such a theory can give an adequate explanation of dispersion, as well as an approximate explanation of aberration, while suggesting at the same time a corpuscular theory of matter itself.

The behaviour of electrons is best studied in the vacuum tube, say of X-ray pattern. At very low pressures the discharge seems to consist almost entirely of electrons, although positive rays are also present in small quantities and can be isolated. It is the streams of these electrons that constitute the so-called cathode rays, which follow a straight path, no matter where the anode is placed, and are deflected by a magnet. When these are reflected by an aluminum shield, the resulting change of momentum yields the ethereal pulse which is held to be propagated as X-rays. It is believed that such a discharge tube contains electrons, positive particles, and neutral particles, existing in varying proportions under varying conditions of pressure and electric intensity, and as such has supplied a fruitful field of inquiry as to their properties.

Even more remarkable than this is the behaviour of radioactive substances. It has now been established beyond doubt that they spontaneously suffer disintegration, giving off the so-called α-rays which are charged helium atoms carrying two units of positive charge, β-rays which are electrons possessing much greater velocities than the cathode rays generally and γ-rays which are of the nature of the X-rays.

We have thus in solids, liquids and gases, which may be taken to be different types of singularities of the electro-magnetic field, agglomerations of less complex structure, the properties of which are intimately connected with those of the electro-magnetic field which modern Physics is attempting to decipher.

The same postulate of an electron, as a physical entity, was arrived at by Lorentz and Larmor, on theoretical grounds. It is indeed implicitly contained in Maxwell's theory. He gives *two* equations involving electric displacement; one apparently appropriate to free ether, the other to media containing free electricity. When this is interpreted in terms of the electron theory, it is found that the total current (which is subject to the condition that the current of an incompressible fluid must satisfy) is found to be made up of a polarization current and an electronic current or current due to electrons in motion. It is further found that it is not necessary to regard magnetism as a separate entity at all but a condition of the ethereal medium (say velocity of the medium) due to the motion of electrons, and that the polarization current may then be regarded as ethereal current moving at right angles to the magnetic disturbance. The processes involved may be further visualized, if we recall that an electric charge is associated with a number of what J. J. Thomson has called Faraday tubes of force, which must move with the moving electron. We must conceive, in fact, issuing from the source of electro-magnetic energy, Faraday tubes which move through the medium at right angles to themselves along the line of energy-flow, with the velocity of light, as an essential constituent of the phenomenon of radiation. And we may explain the associated properties of magnetism by saying "that the disturbance of the field of ether exerts influence in the same general kind of way as the pressure, involved in the inertia of moving fluid, controls the motion of the vortices or solid bodies which are immersed in the fluid" or are travelling in it. The familiar example in hydro-dynamics, of motion of a sphere or a cylinder through a frictionless fluid will occur to all.

The hypothesis of electrons may seem to that extent to be a modification of the generalized statement of Lodge. But it appears that the mass of an electron is—partly at least—to be attributed to its motion, while as to the charge, nothing more is so far known except that it may well be associated with a vortical spin. Moreover, since the electron is a constituent of a material atom, the mass of a material particle as well as the properties of positive particles may well depend on motion. In the same way, the magnetic molecules so-called may be simply revolving doublets of electrons and positive particles in the ethereal medium. It is conceivable, in fact; that in the primordial ethereal fluid medium, various processes are going on which are not only associated with the propagation of radiation but also with the properties of corpuscles and gross-matter, representing various singularities in the field. The corresponding motions may be of the nature of those of vortex rings in a fluid in which portions in rotational and irrotational motion are freely mixed together and which Lord Kelvin has called a vortex sponge; but new difficulties have been recently suggested, which will naturally modify speculations on these lines.

One of these is concerned with the new idea of energy, which suggests that just as we have to postulate, not merely a sub-multiple of the chemical atom but also an atom of electricity, similarly, we have to admit the existence of an atom of energy; so that an oscillation giving out radiant energy must be conceived to give out always an amount, proportional to its frequency and the medium or the recipient of the energy to receive, necessarily, an equal amount, the constant of proportionality being a universal constant which has been called Planck's constant. This has been called by Einstein a light quantum and seems to indicate that the changes involved are due to impulses. If this is indeed the case, it looks as if not only the X-rays but all rays are propagated by pulses. This may account for many outstanding problems such as the bright line spectra of incandescent gases; but without entering into these details, it is not difficult to see that such a theory, if it proves acceptable, will profoundly modify our entire conception of the processes operating in the electro-magnetic field. For, if we must accept the operations of finite forces in effecting changes in the field, we have to admit that we can be cognizant of time, only as durations and intervals, as small as we like, but *not* as the continuously flowing quantity of Newton. There is, of course, nothing objectionable in this purely conceptual definition of absolute mathematical time, but it would appear, on the *quantum* theory, that our faculties impose a limitation on its perception.

The question of aberration raises difficulties of another kind.

When star places were accurately observed, Bradley found that they all appeared to describe small ellipses parallel to the ecliptic and to complete a cycle in a year. It was, therefore, a priori, evident that the observed motion was only apparent and must be due to the motion of the observer, carried by the earth in its motion round the sun.

On the Undulatory theory, however, the explanation naturally presented a difficulty, as the operation of the medium had necessarily to be taken into account. An explanation based on the elastic solid theory was possible, provided we assume the operation of a body force proportional to the second differential of displacement with regard to time, but this is a mere matter of analysis which does not seem to be capable of physical interpretation. The explanation offered by Fresnel gave, however, a result, at any rate correct up to the first order, and proceeded on the hypothesis that a portion of the ether in the space, occupied by the moving body, is bound with the body and is carried with it with the velocity it possesses, the rest being free ether and stationary, as in free space. Accordingly, when a ponderable medium is in motion the velocity of light in it is increased by a fraction (the dragging co-efficient of Fresnel) of the velocity of the medium—a conclusion which the experiments of the Fizeau amply verified. Fizeau's experimental device was to divide a beam of light into two portions which passed along two parallel tubes in which water flowed in two opposite directious, with the same velocity and then cause them to interfere. The shifting of interference fringes with stationary and flowing water enabled the dragging co-efficient to be calculated, and it was found to agree with Fresnel's theoretical value.

The effect in Fizeau's experiments, depending as it did on the velocity of the medium (water), gave no information as to the velocity of the earth. (Relative to the constant ethereal medium of Fresnel). If, however, instead of two parallel tubes, two tubes at right angles to each other are taken with their directions, along and perpendicular to the direction of the earth's velocity and by a suitable arrangements of mirrors, the two beams are finally made to interfere after they have traversed the tubes, there will be interference fringes. If now the whole apparatus is rotated through 90°, the resulting displacement in the fringes, if any, will depend on the square of earth's velocity, relative to the ether. This is the principle of Michelson and Morley's celebrated experiments, but no such effect has actually been observed. Thus, the conclusion is either that the ether of space is moving with the velocity of the earth, which is evidently untenable, or that there is some compensating cause which leads to the null-effect observed.

If, for instance, as was suggested by Fitzgerald, either of the tubes contracts in the process of the experiment by a suitable amount, a contraction which will again require explanation in its turn, the null-effect is explained; but if this is the case it follows that it will not be possible, by means of any such experiment, to find this relative velocity, if it exists at all. Moreover, experiments show that no optical, electrical or mechanical effects are observable that can be ascribed to the contraction, on Fitzgerald's hypothesis, so that there must be causes nullifying the effect of contraction, as deep-seated as the mechanism of these phenomena themselves. We have seen that neither Maxwell's simple theory nor Hertz's modification of it for a moving media is competent to account for aberration, even up to first order effects, as observed in Fizeau's experiments. With the help of the electron theory, however, the Fresnel formula can be obtained on the simple postulate that the total differential with regard to time, involves the velocity of the moving medium, as in hydrodynamics. But in order to explain the null-effect of Michelson and Morley's experiments, we have to adopt the procedure of Lorentz and Larmor. This is to transform the equations of the electro-magnetic field, in terms of new co-ordinates referred to moving origin; the new X, Y, Z, T being related to the old Xo, Yo, Zo, To, so that after transformation, the form of the equations remains unchanged. This requires not only that the new co-ordinates should involve To, but that the new T should involve Xo, Yo, Zo. This amounts to the assumption that the charge of an electron and the associated magnetic field are invariants for all such transformations. It is then found that the Fitzgerald contraction can be explained as well as the various null effects, already referred to.

An altogether different and novel explanation of these has been offered by Einstein who proceeds on the following principle which he called the principle of relativity.

The laws of physical phenomena are the same, whether these phenomena are referred to the system of co-ordinates in any frame of reference or any other system of co-ordinates moving uniformly with respect to the former system, with any arbitrary velocity whatsoever. Now it is well known that the ordinary equations of motion remain the same, whether the axes are fixed or are moving uniformly, so that stated in this form, the principle does, by no means, appear to be new. But the special implication contained in the principle is that time in the moving system depends on the time as well as the corresponding space-co-ordinates of the first system as in the previous theory. The difference, however, between that theory and Einstein's is important, for the principle on which the relation between the two times is determined is different, being in Einstein's theory based on the following additional postulate:

viz. that the velocity of light propagation is the same, whatever the frame of reference (whether the source is at rest or in motion), and it is then found that the equations of transformation from x_o, y_o, z_o, t_o, to x, y, z, t, are the same as in the electron theory of Lorentz and Larmor, and the Fitzgerald-contraction as well as other null-effects are then similarly explained.

I may cite the simple case of local time which depends on the standard time as well as the position of the observer. Of this, Einstein's conclusion may be held to be a generalisation based with the further proviso as to the constancy of light velocity. With regard to the latter principle, it should be borne in mind that all our observations, celestial as well as terrestrial, are ultimately based on an optical method, and all our standards depend on the velocity of light. Since, therefore, any uncertainty in this would introduce a complete uncertainty into the entire range of our experience, Einstein's postulate of constant light velocity, which also enters as a constant in Lorentz and Larmor's equations, seems to be a priori justified.

The justification of a theory is best measured by its power to explain outstanding problems, and accordingly an attempt has been made to apply the theory of relativity to explain several phenomena of this nature. I shall refer to two of these:

The want of exact coincidence between the wave lengths of the solar lines and those of the corresponding elements as observed in laboratory spectra has engaged the attention of observers for a long time. Mr. Evershed of Kodaikanal in a paper read before the Science Congress last year referred to a suggestion of Dr. Walker's that this might possibly be connected with relativity phenomena Since,. then, however, he has made further researches and he now writes to me to say that it is now certain that the red shift on the sun is not even in part due to Einstein effect.

Another outstanding problem is the celebrated discrepancy between observed rotation of the orbit of mercury (574 seconds per century) and the calculated amount, on the Newtonian theory of perturbation due to the action of the other planets (about 532 seconds). This it has been claimed can be completely accounted for on the theory of relativity, but it has been argued on the other side that a suitable modification of the Newtonian theory is competent to yield the same result also. It does not appear, in fact, that a final pronouncement on the point is as yet possible.

It must be admitted, however, that the future is rich with possibilities for this theory. If this is so it suggests a difficulty, which though serious does not seem to be insurmountable. For it seems to indicate that any two frames of reference, are equally valid frames of reference, no matter how they are moving relatively to each other provided the unique condition as to the constancy of light velocity is satisfied, with reference to them. If one of these frames of reference be situated in the ethereal medium, supposed to be the same as the electromagnetic field, this apparently leads to the conclusion that the ether may be supposed to be moving with any arbitrary velocity, whatsoever.

Now various lines of arguments seem already to point to the conclusion that the electro-magnetic field, if identified with an ethereal medium cannot be held altogether to be either inert or immobile. There is the intrinsic (kinetic) energy of the field to be accounted for, as well as the property of the medium as a carrier of momentum of radiation. And as to the arbitration of the postulated velocity, since such a medium may be also a field for other phenomena besides electromagnetic, such as gravitation, it does not appear that the theory of relativity, even if it ultimately proves acceptable, will dispose of the physical existence of the ethereal model, until a better one can be found which shall explain the intimate nature of the various concepts of modern physics, corpuscles and positive particles, electric charge and magnetic force, gross matter and gravitation, in one comprehensive scheme.

And whatever that line of progress should be, it must follow the principle, stated by Tait, that our science is to be based entirely upon experiment or mathematical deductions from experiment. And it is not surprising that in recent years, side by side with the evolution of new physical ideas, the foundations of mathematics have undergone a careful scrutiny. In fact, since functions enter so fundamentally into a mathematical discussion of all physical measurements, a careful study of the exact meaning of continuity of functions, of limit, of infinity, have removed much vagueness and want of precision that previously obtained. The theory of Fouriers series, for instance, in its original form and much subsequent applications took, as we know, much for granted. An enquiry has been successfully instituted in recent times as to the extent to which these assumptions are valid, and this has led to a clear understanding of a function of a real variable, of convergency and of infinite series.

We now know that the calculus has many and important limitations, that we cannot differentiate a function at random, that the integral calculus is practically powerless, unless the result of integration is expressible by algebraic and logarithmic functions. An attempt to extend its scope has led to the theory of periodic functions and theory of functions of a complex variable. And remembering that vector-algebra of three variables and Minkowski's four dimension calculus really deal with similar functions in three or four dimensions, we may well look for important generalisations of the theory from the point of view of modern physics.

Again it may be well to remember that application of mathematics to physics is based on the postulate that physical problems can be expressed by differential equations. But it is now recognized that our knowledge as to the possibility of solving differential equations is of the most meagre description. An inquiry into the subject, which has been largely undertaken in recent years, is of immediate physical interest though it is generally classed under pure mathematics.

In the same way, a new investigation has been undertaken into the logical foundation of the principle of Least Action, on which an attempt is made to deduce the entire history of a dynamical system. And it appears that the insistence of the pure mathematician on the need for rigorous and powerful methods in this and similar problems, such as the question of the stability of the solar system, has immediate and pressing interest to the physical enquirer.

Talking of the foundations of the dynamical theory, I cannot omit to refer to the change of *Method* due to G. W. Hill and others, whereby planetary and lunar theories have undergone complete transformation. The orbit of a planet due to the undisturbed action of the sun alone is, as is well known, an ellipse. But the presence of the other planets produces disturbances, which previously used to be introduced as approximations which produced a slow revolution of the orbit. The new school recognized that a revolving orbit is different essentially from a fixed orbit, and this has introduced a remarkable simplicity into the treatment of celestial mechanics.

All these have immediate interest to the physicist, but in this section it is unnecessary to omit all reference to a few subjects which are at present of interest to the pure mathematicians alone, though their physical bearing, in the near future, may open up new fields of research to the physical inquirer as well. Take the comparatively recent subject of non-Euclidian Geometry. At a time when through the principle of relativity, the property of space is being reconsidered, non-Euclidian Geometry may have far-reaching significance, but, apart from that, the justification of such a study is to be found in the highly interesting results it has already yielded.

Similar remarks apply to the theory of groups and the theory of numbers.

A group is a set of operations, which is closed, in the same sense that the performance of any two of these operations in succession is equivalent to another operation of the set. We know, for instance that the result of a successive translation and rotation of a rigid body is equivalent to a single movement. And it is clear even to the uninitiated like most of us that the subject is likely to be fruitful on both the physical and mathematical side. And as to the theory of numbers it is only necessary to mention that men of highest mathematical genius, such as Gauss and Dirichlet, who are also among the founders of Mathematical Physics, have devoted their energies to the elucidation of the mysteries of numbers, which, indeed, enter fundamentally into all physical measuremants.

The two branches of science, with which we deal in this section, are neither the rivals nor handmaidens of each other. Properly pursued, they help each other and both attempt to elucidate the wonderful mysteries that surround us, within, it has to be confessed, a very limited sphere. Physical Science is but engaged in evolving a model, a mechanical model though it be, of the universe, and Mathematics, in setting in order the manifold activities of human intelligence. And we should bear in mind that this is a never-ending process and that the truth we seek but form part of a greater whole. If we do so, and in so far as we do so, our quest can never prove either meaningless or barren of results.

Quantum theory of electric discharge.—*By* D. N. MALLIK *and* A. B. DAS.

On the quantum theory, the energy of a vibrating system is a quantity which depends only on the wave lengths of the radiations emitted. It follows therefore that as the spectrum of an incandescent gas in a discharge tube is characteristic of the gas, the minimum energy required for the ionisation of the gas in such a tube, when attended with luminosity, must be a constant for the gas This being admitted, the length of the Faraday dark space would be the distance through which an electron moves under the electric field before it acquires this amount of energy. The paper considers the experimental results of previous workers, as well as those obtained by the authors, which seem to support this view. The relationship between the mean free path, the cathode fall of potential, as well as the minimum potential difference required for a spark and this energy is also considered.

The curved paths of billiard balls and curling stones.—*By* GILBERT T. WALKER, F.R.S.

The dynamical eccentricities of most of the objects used in our games have received a qualitative if not a quantitative explanation: and the two exceptions known to me form the subject of this paper. A billiard ball struck with right side will curl to the right if it runs with the nap of the cloth, but to the left if running against it; and the explanation is extremely simple, the rubbing up of the nap on one side of the ball's path producing the effect of an inclined plane with that side raised, so that the path bends continuously away from the side on which the nap is being rubbed up.

A curling stone will, when the ice is not much below the freezing point, curve on flat ice to the right or left according as it is rotating clockwise or counter-clockwise. The explanation is shown to lie in a paradoxical behaviour of the friction which is less on the forward than on the rearward half of the stone although the pressure on the forward side is greater: and this is due to the property of ice of melting under sufficient pressure, the property which renders skating possible.

Earth-air current at Patna.—*By* V. H. JACKSON *and* K. N. BANERJEE.

Most of the measurements of the earth-air current hitherto recorded have been made by eye observations only, which are necessarily limited in number. In consequence, very little is known regarding the diurnal and annual variations. Automatic records of the atmospheric conductivity and potential gradient have been employed by Kahler at Potsdam and Dorno at Davos in order to deduce the current. A more direct automatic method of measuring the charge gained by an insulated plate exposed to the air and kept at zero potential was devised by Simpson at Simla, but his published results refer to a period of only ten days in the month of November 1909.

Owing to difficulties connected with the water-dropper and with the insulation of the large plate necessary in this arrangement, the authors have adopted an alternative method also suggested by Simpson, and after numerous trials have converted it into a satisfactory automatic method. The current is obtained from measurements of the potential acquired by a plate level with the earth and exposed to the air, during a definite period (4 minutes) after it is insulated from the earth. The potential is kept below one volt by the introduction of suitable capacity, and is measured by a sensitive Dolezalek electrometer, the deflections being recorded photographically. The variation of the potential gradient, which introduces a correcting factor, is recorded by a Benndorf electrometer and radium collector.

The authors give details of the final form of the arrangement, which was adopted in August 1918, and discuss the results of a reliable preliminary series extending over the whole of the months February to May 1917 and February to April 1918. It appears that while the diurnal range of the earth-air current somewhat resembles that of the gradient there are no definite signs of the double period which is a marked feature of the latter. The conductivity during these months is highest during the early afternoon. The mean value of the current, about $1{\cdot}8 \times 10^{-16}$ amp./cm.², is rather lower than most of the values which have been obtained elsewhere, but there are indications that as in the case of the gradient the earth-air current at Patna reaches its minimum in the month of April.

A method of measuring the capacity of gold-leaf electroscopes.—*By* A. T. Mukerjee.

The arrangements for using a Dolezalek electrometer for accurate work, devised by V. H. Jackson and the present author (continuation of earlier work described in J.A.S.B., Vol. 10, No. 6, 1914), and shown in working order at the fifth session of the Indian Science Congress at Lahore, 1918, have made it possible to develop a quick and very accurate method of measuring extremely small capacities, such as those of gold-leaf electroscopes. Using a standardised (Gerdien) sliding condenser, the absolute value of the capacity of the quadrant system, including a specially designed connecter, is first determined by the method of mixtures. The gold-leaf system of the electroscope is then charged to a known voltage, adjusted so that when the charge is shared with the quadrant system, the final potential, as measured by the electrometer, is not far from one volt. As the capacity of the quadrant system can be varied by the sliding condenser, the capacity of the electroscope can be measured at different voltages. There is a small but definite increase of capacity with voltage. The method is compared with those of Lester Cooke (Phil. Mag. Vol. 6; 1903, page 410) and T. Barratt (Proc. Phys. Soc. London, 1916, Vol. 28, pages 162–171). The capacity of a small β-ray electroscope charged to about 100 volts has been measured by the three methods with the following results:—Present method 0·78 ± ·01, Lester Cooke's method, as improved by the author, 0·75 ± ·01, and Barratt's method 0·73 ± ·03 E.S.U.

Some observations of the ionisation of the air in India.—*By* A. Steichen.

In the years 1917 and 1918 I examined the ionisation of the air in 5 different places in India. I had a double object in view when beginning the work. My first object was to get some numerical values of the ionisation of the air in India, as only very little is known about the ionisation of the air in tropical climates. My second object was to ascertain the influence of the nature of the rock on the ionisation of the air. My places of observation were chosen so as to suit this double object. Observations were made in the following localities :—

1. Bombay and Khandala, in the Deccan Trap (basalt),
2. Mt. Abu, in the Archaean gneiss.
3. Tumrikop, in the Dharwars (old sediments).
4. Anand, in the Alluvium (Pleistocene).

I consider my work to be still unfinished, and I intend to continue it in some more places.

Summary of Results.

1. E has been measured in 5 different places.
2. As a rule ${}_+E > {}_-E$ or ${}_+E = {}_-E$ nearly, only exceptionally ${}_+E < {}_-E$.
3. In certain places as at certain times in the same place $E_{\text{a.m.}} > E_{\text{p.m.}}$, in other places $E_{\text{a.m.}} < E_{\text{p.m.}}$ The inequality depends much on the state of the air as to smoke, dust, humidity, direction of the wind in the morning and in the afternoon.
4. ${}_-E$ is more affected by impurities of the air than ${}_+E$.
5. Great and rapid changes of E were observed.
6. No influence of the difference in elevation on E has been observed in Bombay and at Khandala.
7. In Bombay the air coming from the land seems to possess a higher electric charge than that coming from the sea.
8. The influence of the humidity of the air on E is obliterated in Bombay by other uncontrollable factors.
9. The nature of the rock and soil in a district seems to affect E considerably.

A new form of parallel plate interferometer.—*By* H. PARAMESWARA IYER.

A short account is given of experiments made with a parallel plate interferometer formed by a layer of liquid on top of a layer of mercury.

A scientific definition of the consistence of mortar.—*By* R. S. CREE BROWN.

The paper states the difficulty of measuring the consistence of lime mortar, on which the crushing strength very largely depends. A modification of the Vicat needle is described, whereby a cone, weighted with 250 grammes, is lowered into a pat of the mortar 40 mm. thick. The distance from the point of the cone to the base of the specimen, when equilibrium is established, is read in millimeters, and is called the Consistence Number. It is shown to vary inversely with the quantity of water present in the mortar.

The meaning of this number is further analysed, and its connection with the "Hardness Number" of Brinell and Martel is shown. With the apparatus the Hardness Number of freshly made mortar can be ascertained to the same scale as the hardness number for steel. The physical meaning of this number is discussed.

Mutual potential.—*By* D. N. MALLIK.

In a former paper the author investigated an expression for mutual potential in the form of an integral involving surface elements with applications. The present paper deals with further applications of the same formula.

On the fundamental law of electrical action.—*By* M. N. SAHA.

In this paper the law of attraction between two moving electrons has been investigated according to the principle of relativity-electrodynamics. The potential four-vector (i.e. the four dimensional vector having the vector potentials as the space-components, and —I the scalar-potential as the time component) obtained by the author is different from that obtained by Sommerfeld (Ann. der Phys., vols. 32 and 33). The components of the electrical and magnetic forces are given in one formula as the 6-components of the four-dimensional curl of this vector. The ponderomotive force (i.e. force exerted on a second electron moving in the field created by the motion of the first) is given in accordance with Lorentz's theorem. The fundamental equations of motion of an electron are then deduced from the Principle of Least Action. It is then shown that the equations obtained are simply a different form of the Minkowskian Equations.

On some problems of spectral emission.—*By* M. N. SAHA.

In this paper, the problems of spectral emission are discussed from the standpoint of the structure of atoms and molecules. It is shown that of the vast range of spectral emission, only the two extreme limits—the problem of emission from a perfectly black body and the emission from a system consisting of a central positive nucleus and a single electron—have received adequate theoretical explanation. The causes which are responsible for the production of complexity in spectral emission are next considered. In this connection the influence of Doppler-effect (due to heat motion of emission centre) and of external electric and magnetic fields (Stark and Zeeman effect) are discussed. An example is taken from the emission spectrum of hydrogen. It is shown that the secondary spectrum of hydrogen is due to the hydrogen molecule, whilst the primary spectrum is due to the hydrogen atom. The ordinary spectrum of helium is next considered.

It is shown that in the light of the quantum theory, the problems of emission may be classified :—(i) problems of general atomic-emission ; (ii) problems of molecular-emission, i.e. emission from a system containing two atomic systems combined in a molecular grip.

The dynamical equations with the quanta-conditions have also been investigated.

Notes on some newly designed physical apparatus.—*By* J. N. MAITRA.

The paper contains a short descriptive account of physical instruments specially designed and made for lecture demonstration. (i) a differential caloriscope, (ii) a hydrodynamic model for showing flow of heat along a bar heated at one end, (iii) apparatus for exploring the temperature gradient along a hot bar, (iv) demonstration apparatus for showing conductivities of rods of different metals, (v) apparatus for comparing thermal conductivities by a null method, (vi) apparatus for showing the adiabatic heating of suddenly stretched India rubber, (vii) apparatus to show apparent contraction of stretched India rubber on heating, (viii) hydrostatic trough with sliding partitions to show that the pressure of water depends on the head of liquid, (ix) combined hydraulic and gas tourniquet, (x) apparatus to show the convection of hot air, (xi) a new commutator, and (xii) an apparatus to investigate the longitudinal elasticity of a wire.

A new coefficient of correlation with applications to some biological and sociological data.—*By* P. C. MAHALANOBIS.

Section of Chemistry.

President:—F. L. USHER, ESQ., B.Sc.

(*Presidential Address*).

A REVIEW OF THE EVIDENCE FOR TRANSMUTATION.

To form a sound and dispassionate judgment on a controversial matter while the evidence on both sides is still in course of production, is a task that requires a rare critical faculty to which few can lay claim. Four years have, however, elapsed since the last contribution was made to the subject of the supposed transmutation of the elements, and there are several reasons why I now venture to offer some remarks on it. One is that, to some at least, the contemplation of a little pure chemistry will be a welcome diversion amid the plethora of industrial problems that have lately been our portion; another is that at one time I had the opportunity of a fairly close acquaintance with some of the work; and the most important reason is the great interest which the subject itself must have for the chemist, chiefly, perhaps, because it appeals to his imaginative as much as to his intellectual faculty.

The evidence for transmutation is of two kinds, observational and experimental. *A priori* arguments based on modern theories of the constitution of the atom cannot be admitted as evidence, although they may be instrumental in removing some of the difficulties in the way of accepting such evidence as may be forthcoming.

By observational evidence I mean evidence that certain elements have appeared as the result of some natural change, under circumstances which preclude the possibility of their having been imported, ready-made, from another place; or of their having been present unobserved prior to the final observation.

The only observational evidence which we need consider at present is, first, that which is based on spectroscopic examination of the celestial bodies, and, secondly, that which has, for the past decade, been accepted as an established part of the phenomena of radioactivity. Few chemists who have given any thought to the matter are likely to reject the conclusion that transmutation of the elements—what has been termed inorganic evolution—is actually taking place in the remote parts of the stellar system. Indeed, if we accept the opinion of astronomers regarding the relationship of stars to nebulae, such a conclusion appears to be inevitable. There is, if possible, even less doubt about the degradation of the radioactive elements, which can be observed by the chemist within the limits of his own laboratory. The outstanding feature of these transformations is their entire independence on any conditions which it has been within human power to impose, and it must be admitted that this indifference to all the charms in the repertoire of the modern chemist and physicist can hardly be considered a favourable omen for their attempts to carry out a process similar to one over which they cannot exercise the smallest control.

Nevertheless such attempts have been made, and if no definite conclusions are apparent, the reason lies rather in the difficulty of interpreting the meaning of the experiments, than in any doubt regarding the results.

I propose to pass over the earliest work, done by Cameron and Ramsay in 1907, on the production of lithium from copper solutions by the action of radium emanation, not because their results have been proved to be of no significance, but because sources of error which they did not suspect were afterwards discovered, and because no positive results have been obtained when those sources of error were absent. The subsequent work has been of a different kind, in that the alleged products of transmutation have in every case been gaseous, and it has therefore been possible to work in closed apparatus and to guard more effectively against contamination from without.

In December 1905, Ramsay dissolved 270 grams of carefully purified thorium nitrate in water, and sealed up the solution in a flask which was then thoroughly evacuated. After 168 days, the flask was again attached to a pump and the small quantity of gas which had accumulated withdrawn. The presence of helium, the detection of which was the object of the experiment, was doubtful, but a gaseous substance which condensed in liquid air to a snow-white solid was observed. It appeared to be carbon dioxide, but was not further examined. The same solution was again evacuated and examined after a further period of 250 days. The gases withdrawn contained 0·588 c.c. of carbon dioxide. After 168 more days 1·08 c.c. of carbon dioxide was found. At this stage a control experiment was set up, consisting of a solution of 300 grams of mercuric nitrate contained in a similar flask and treated in exactly the same way. From the 14th August, 1907, to the 30th March, 1908, 1·209 c.c. of carbon dioxide was obtained from the thorium nitrate solution, and 0·015 c.c. from the mercuric nitrate. On the 9th February, 1909, a further quantity of carbon dioxide, amounting to 0·622 c.c. was recovered. Thus the same solution of thorium nitrate had given off about 4 c.c. of carbon dioxide, in a little less than three years, and showed no signs of stopping.

Among the various possible explanations of the origin of the carbon dioxide, which I will refer to presently, is the one which postulates a degradation of the element thorium, under the influence of its own radiations, to the lowest member of the group. If this explanation were correct, it should be possible to obtain carbon from thorium, and possibly from other elements of the fourth Group by submitting them to the action of a more intense radiation than thorium is capable of furnishing, and the rate of production should also be more rapid. Accordingly a new series of experiments were undertaken by Sir William Ramsay and myself in 1909, in which solutions of thorium nitrate, lead chlorate, zirconium nitrate, titanium sulphate, and hydrofluosilicic acid were treated in small sealed glass bulbs with radium emanation. Control experiments with mercurous nitrate were performed at the same time. In these experiments the quantity of liquid treated was in each case about 5 c.c., and the amount of emanation used about 0·1 c. mm. In every case save that of mercurous nitrate carbon in the form of one or both of its oxides was obtained, the actual quantities varying from 0·063 c.c. with hydrofluosilicic acid to 0·551 c.c. with thorium nitrate The amount of carbon obtained varied directly with the atomic weight of the element treated, except in the case of lead, which furnished only 0·013 c.c.

It will be noticed that the suggestion here is that thorium and its group relatives may have been degraded by the action of radiations proceeding either from itself or from an extraneous radioactive body; and such a process is entirely distinct from any known natural radioactive process. It is true that the radioactive emanations, gases belonging to the helium group, are partially transformed into helium, the lowest member, but this is an accidental coincidence due to the fact that α-rays consist of helium. The experiments are, however, to be judged on their merits. Whence comes the carbon? Excluding for the moment the hypothesis of transmutation, the atmosphere, the glass vessels used, and impurities in the solutions remain as possible sources. The first may be rejected, since the amounts of carbon dioxide found would correspond with a leakage of air very many times greater than the capacity of the vessels used. The solutions employed were all acid, and so could not absorb carbon dioxide selectively; they were prepared with extreme care, under conditions which secured the absence or the destruction of any organic matter, and never came in contact with filter paper or other carbon-containing material. There remains the glass, on the surface of which it is well known that small quantities of carbon dioxide can be absorbed. Collie has shown that small amounts of this gas can be evolved persistently from carefully cleaned glass vessels under bombardment by cathode rays, and presumably also under the action of the radiations we are considering. In this connection it is pertinent to call attention to two points: first, that no carbon dioxide or monoxide could be found in the gases from mercurous nitrate; and secondly, that glass itself contains silicon, one of the elements which the transmutation hypothesis regards as being capable of degradation to carbon. A strong argument against the absorption explanation is that the internal surface of the vessel at the end of an experiment must have been greater than at its commencement, owing to the pitting action of the α-rays; and that if carbon dioxide could not be removed during the preliminary exhaustion, there was even less chance of its removal during the final one. I venture to think that these experiments furnish a strong case for further investigation, preferably with the use of quartz vessels, and that meanwhile the impression left on the mind of an unprejudiced critic is not unfavourable to the hypothesis of transmutation.

We come now to a series of investigations on the production of two inactive gases, helium and neon, as transmutation products. Here again the earliest work, in which Cameron and Ramsay, in 1908, observed the presence of neon in the gases produced by the action of radium emanation on water, may be passed over because the precautions observed were not such as were subsequently found to be necessary. We may, therefore, start with the observational evidence recorded by Ramsay in 1912, in investigating the composition of the gases evolved from the water of the King's Well at Bath. They consisted mainly of nitrogen, and contained in addition 0·726% of argon, 0·233% of neon, and 0·030% of helium. The corresponding figures for atmospheric air are: argon 0·932, neon 0·012, and helium 0·0004. The inactive gases in the water may have been derived from the atmosphere, or by radioactive changes. The only known source of argon and neon is atmospheric air, whereas helium is one of the commonest products of radioactive change. The water in question contains dissolved radium, and is saturated, under the conditions obtaining, with emanation. The helium, which is present to the extent of 73 times the amount in atmospheric air, is almost certainly derived from this radium and emanation; the argon, which amounts to three-fourths of the quantity present in air, is probably atmospheric in origin; the neon, of which there is 188 times as much as is present in air, is not so easily accounted for. If it is of atmospheric origin there should be a correspondingly large proportion of argon also: if it is not from the atmosphere it must be a product of radioactive change. In support of the latter alternative, Ramsay found that emanation which had been left to decay in an aqueous solution of thorium nitrate, or simply in water, gave rise to neon when the most stringent precautions were taken against the entrance of traces of air. In one such experiment, the neon spectrum observed was more brilliant than that of the neon from 0·5 c.c. of air, whilst the argon spectrum was invisible unless a jar and spark gap were interposed, when the blue lines became just visible.

It is evident that the crucial question is whether or not sufficient air leaked in to account for the neon observed. Experiments similar to those performed by Ramsay were carried out by Rutherford and Royds, who were able to detect the neon from 1/15 c.c. of air, but failed to detect any in the gas produced by the action of emanation on water. These two sets of results are typical of all the more recent work in this field: on the one hand, experiments performed with extreme care, leading to positive results; on the other, experiments made with at least equal care and leading to negative results, the conditions being apparently the same in both cases. I will postpone any comment on this apparent deadlock until we have considered the remainder of the evidence, and will only suggest here that those who are of opinion that the alleged production of neon from water is disproved by the very careful work which has given negative results, may not unreasonably be asked to explain its occurrence in the gases from the King's Well, Bath, in relatively enormous quantity.

In 1912, Collie and Patterson, working independently, and in ignorance of each other's experiments, obtained some very remarkable results while investigating the action of an electric discharge in highly exhausted vessels. It had been shown by Ramsay in the same year that the glass of old X-ray bulbs which had become deeply coloured through long use, gave off an appreciable quantity of helium, mixed with a trace of neon, when heated in a vacuum. Since the quantity of helium found, had it been of atmospheric origin, would have required the leakage into the bulb of 22 c.c. of air, and since the bulbs, originally exhausted to the point of strong fluorescence, had been washed out four times with pure oxygen before being heated, it was probable, although not certain, that the inactive gases had been generated within the bulb by the electric discharge. Thus the ground was prepared, in some measure, for the later published results of Collie and Patterson. Collie found that fluorspar, when bombarded by cathode rays, changed colour and evolved considerable quantities of gas, chiefly hydrogen and carbon monoxide, and that a small residue of neon was left after removing the other gases. A similar result was obtained on substituting for the fluorspar some very pure calcium fluoride prepared by treating freshly burnt marble with excess of hydrofluoric acid and heating the fluoride to a bright red heat for two hours. In another experiment carefully cleaned glass wool was used in place of the calcium fluoride, and neon was again obtained; as it was also in an experiment where the tube contained nothing but a little pure hydrogen. Helium was not found in these experiments except in small traces. Blank experiments were made on the gases, glass, and aluminium electrodes employed, but in no case in which the discharge had not passed could any neon be detected.

In view of the possibility that the tubes themselves might be permeable to atmospheric neon while the discharge was passing, the discharge tube was enclosed in an outer tube, which in one experiment contained helium, and in another was exhausted until a discharge would not pass in it. In both these cases the usual quantity of neon, quite free from helium, was found in the inner tube; but in the one in which the outer tube had been evacuated, on washing the latter out with a little pure oxygen, a residue was obtained about fifty times as great as that from the inner tube, consisting of nearly pure helium, with a trace of neon.

In the meantime Patterson, working independently at Leeds, had submitted pure hydrogen at very low pressures to the action of the discharge, and had in many cases obtained measurable quantities of neon. He too employed a jacketed tube, with the interspace evacuated, and after the passage of the discharge obtained helium therefrom. On passing a discharge through the inner tube when the interspace was filled with pure oxygen at about 15 mm. pressure, neon, not helium, was obtained. The volume of the helium or neon obtained from the outer jacket, both in Collie's and Patterson's experiments, was about 1 c.mm., the amount from the inner tube corresponding roughly with that in 1 c.c. of air.

The next contribution, by Merton, appeared in the following year. Merton made use of a very simple and ingenious apparatus in which no transference of the gas for examination was necessary, and which had no stopcocks. It was provided with a small palladium tube, which admitted small quantities of hydrogen when heated with a gas flame, and evacuated any hydrogen from within when heated electrically. In a series of experiments on the action of the discharge on hydrogen, no helium or neon was ever detected. The apparatus was then used by Collie, being sealed by him to a vessel in which uranium powder, which had previously been heated in a vacuum, was submitted to bombardment by cathode rays. In eight consecutive experiments, a fine capillary tube full of mixed neon and helium at about 2 mm. pressure was obtained. For the ninth experiment a more powerful coil with a mercury break was used, and no helium or neon obtained; on reverting to the use of the old coil, these gases appeared as before. In no one of these experiments was sufficient argon present to give anything but a faint spectrum with a condensed discharge. A general description of the types of apparatus used, and of the results obtained, was published jointly by Collie, Patterson and Masson in 1915. It was stated that by the cathode-ray bombardment of platinum, thallium, uranium, potassium fluoride, potassium chloride, potassium iodide, rubidium chloride, and caesium carbonate, helium was obtained, sometimes with a trace of neon, whereas if no special anticathode was used, neon was the main product. No helium or neon was obtained from calcium or glucinum oxides.

Finally Egerton repeated some of the experiments which have been described, and obtained only negative results. He also attempted to show by calculation that under the conditions of the experiments, it was unreasonable to expect any detectable amount of helium to be produced from hydrogen in less than about 10 years. The calculation, however, was based on certain assumptions regarding the mechanism of the process, and regarding its energy requirements, in respect to both of which we know nothing.

No survey of this nature would be complete without reference to the results obtained by Sir J. J. Thomson by his positive ray method, particularly as his opinions have been cited both in support of and against the transmutation hypothesis. Without going into details, I may remind you that Thomson obtained helium from a large number of substances, many of which had been purified in such a way as to exclude the presence of helium in them. His published conclusions, which may be regarded as a model of caution, fortunately do not affect his experimental results, which are, qualitatively, similar to those of Collie. But the positive ray method is so exceedingly sensitive that it is better, for our purpose, to rely mainly on the experiments previously described, in many of which the quantities of gas obtained were actually measured, and in all of which they were detected spectroscopically, or not at all.

In forming a judgment on the work as a whole one should, I think, be particularly careful, first, to put aside any theoretical considerations relating to a possible mechanism; secondly, not to permit any experiments which may subsequently prove to have been performed with inadequate precautions, to prejudice one's criticism of those which appear to be satisfactory in that respect; and above all, to remember that negative results cannot invalidate positive ones unless all the conditions are known and understood. In the work under discussion this is far from being the case. Those chemists who have obtained positive results have obtained still more negative ones, under apparently identical conditions. In one instance, as we have seen, a small coil with a hammer break was effective when a more powerful one with a mercury break was not. It may not be out of place to call attention to the extraordinary behaviour, recorded by Gray and Ramsay (J.C.S. Trans. 1909, 95, 1083), of a solution of radium bromide, which had been evolving about 25 c.c. of mixed gases every week for 30 weeks, and which, when a certain piece of apparatus, constructed of lead and paraffin, was placed outside the bulbs containing it, gradually ceased to evolve the gases, the weekly volume of which dwindled to 0·5 c.c., until the apparatus was removed, after which the normal rate of evolution was recovered. Attempts were made to observe this remarkable phenomenon again, and although the conditions were reproduced apparently in every particular, it was never again observed. Although this incident has no direct bearing on transmutation, I mention it as illustrating our ignorance of the factors which determine changes akin to radioactive processes, and the difficulty of reproducing the full conditions of an experiment.

With regard to the actual experiments we have been considering, there has been no question of faulty observation: the results obtained are generally accepted; the sole point of contention is the origin of the products. It would take far too long to enter on a detailed criticism of each experiment, but a few observations may usefully be made. It is evident, in the first place, that in those instances in which helium has been the main or only product, the source can hardly have been atmospheric, for the light inactive gases from air show a strong neon spectrum in which the helium is visible with difficulty. Yet in many cases, notably in the cathode ray bombardment of heavy metals and salts of caesium, rubidium, and potassium by Collie, and in some of the jacketed tube experiments of Collie and of Patterson, helium was the main product. In spite of the criticism of Soddy, it is extremely unlikely that, after the treatment it had received, the 50 grams of uranium powder used by Collie in connection with Merton's apparatus, could have furnished helium in the quantities observed had it been produced by the natural radioactivity of the metal.

Again, turning to the experiments which resulted in the production of neon, it must be remembered that in several cases argon was looked for, and only found in traces insufficient to give the ordinary spectrum, whereas a very minute leakage of air would have given rise to a strong argon spectrum entirely masking that of the neon. Nor must it be forgotten that in those instances where neon "with a trace of helium" has been observed, the helium must have been present in considerable quantity, for comparatively large amounts of helium may be present in neon without the spectrum of the former being visible.

The possibility of the pre-existence of helium or neon in the materials used has constantly been kept in mind, and no trace of either of these gases has been detected when the hydrogen and oxygen used in the experiments were examined, nor when the glass was fused in a vacuum, and the metal electrodes fused or dissolved.

I have purposely refrained, in this brief survey, from attempting any explanation of the results described, because I hold that at the present stage theoretical speculation is useful only in so far as it suggests further experimental work, in which case it may well be left to those engaged therein. Certain theories are naturally suggested by the results already recorded, and when we revert to normal conditions we may hope to hear that the work is being resumed. Meanwhile, the brief review I have attempted will, I believe, have indicated a sufficient balance of evidence on the positive side to justify the continuance of the experiments.

Colloidal antimony preparations.—*By* F. L. Usher.

Many attempts have been made to prepare stable sols of metallic antimony for medicinal use. Chemical reduction methods gave the metal in the form of a precipitate in every instance, except at dilutions too great to be of practical value. By electrical dispersion methods sols were obtained in methyl, ethyl, and *n*-propyl alcohols, and in acetone, methylal, and acetic acid, but except in the case of ethyl alcohol they were very unstable. Attempts to transfer the dispersed metal from alcohol to water led to the formation of unstable sols. The metal was negatively charged, and was rapidly oxidised by dissolved air, and then coagulated owing to neutralisation of the charge. Coagulation also took place when air was excluded.

As regards antimony compounds, it was found that Paal's protalbic acid method is inapplicable to antimony, and no stable sol of the oxide could be prepared. At present sols of the sulphide, of strength 1 in 500, are used. They are very stable when protected with gum arabic.

Hydrolysis of naphthol ethers.—*By* G. B. Kolhatkar.

Methyl and ethyl ethers of β naphthol, methyl ether of α naphthol, and methyl ether of phenol are hydrolysed by 5 N. HCl on a boiling water bath in sealed tubes.

The molecular ratio of ether to HCl was 1 : 100 or some multiple.

The liberated naphthol or phenol was estimated by suitable means.

It was found that ethers of β naphthol are hydrolysed much more readily than those of α naphthol. Phenol ethers show little hydrolysis.

Among the different ethers of β naphthol, the methyl ether is more readily hydrolised than the ethyl ether. The reaction being of a heterogeneous type, the extent of hydrolysis depends mostly upon the volume of the acid used and is only slightly affected by the amount of the ether taken.

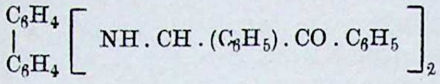
The strength of the acid has a very great influence on the extent of the hydrolysis.

Condensation of benzoin with diamines.—*By* S. C. Chatterjee *and* B. N. Ghosh.

With the idea of preparing substituted naphtho-dipyridines or pyridino-naphthpyrroles, the authors studied the reaction between benzoin and some of the naphthylene diamines, using the corresponding amine hydrochlorides as condensing agents. Only in the case of 1-4 and 1-5 diamines, the reaction took place in the manner desired—a molecule of the diamine combining with two molecules of benzoin with the elimination of four molecules of water. There are three possible formulæ for each of these substances, and, although no conclusive proof is available, on the strength of indirect evidence it has been suggested that each of the two nitrogen atoms in both these substances forms part of a six-membered ring.

Contrary to expectation, the 1-2 diamine yielded a product which appears to be identical with O. Fischer's diphenyldihydronaphthoquinoxaline (Ber. 1893, *26*, 192).

Incidentally, the reaction between benzoin and benzidine was also studied but in this case the closing of the ring did not take place, the compound obtained having the following structure :—



$$\begin{matrix} C_6H_4 \\ | \\ C_6H_4 \end{matrix} \left[NH.CH.(C_6H_5).CO.C_6H_5 \right]_2$$

An attempt was made to close the ring by boiling with acetic anhydride but this only resulted in the formation of a diacetyl derivative.

Synthesis of pyranol derivatives.—*By* A. K. Das *and* B. N. Ghosh.

Ghosh and his collaborators have shown (T. 1915, *107*, 1442; T. 1918, *113*, 484) that aromatic o hydroxybenzaldehyde condenses with substances containing the group -CO-CH_2- CO- to form pyranol derivatives.

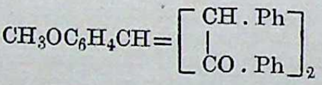
With alkaline hydroxides as the condensing agents the 'salicylidene' compound is first obtained and this or the original substances in alcoholic solution with dry hydrogen chloride gave the desired pyranol derivative.

In the present investigation a substance of similar type such as desoxy-benzoin ($C_6H_5COCH_2C_6H_5$) was taken. Here the methylene group is situated between a carbonyl and a phenyl group instead of two carbonyl groups.

The desired pyranol derivative was isolated by treatment with dry hydrogen chloride but the intermediate 'salicylidene' compound could not be obtained with alkaline hydroxide as the condensing agent. This appeared rather unnatural and hence p-hydroxybenzaldehyde was substituted for the ortho compound. But in this case also nothing separated with alkaline hydroxide although with hydrogen chloride a substance was obtained which could not be crystallized.

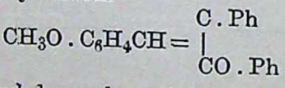
This seemed peculiar and therefore the investigation was further extended to other aldehydes such as anisaldehyde, piperonal, and p-toluyl aldehyde with both acid and alkali as condensing agents.

With alkaline hydroxide, anisaldehyde and desoxybenzoin gave (1) anisamaron



$$CH_3OC_6H_4CH{=}\left[\begin{matrix} CH.Ph \\ | \\ CO.Ph \end{matrix}\right]_2$$

and with dry hydrogen chloride under different experimental conditions (2) iso-anisyl desoxybenzoin



$$CH_3O.C_6H_4CH{=}\begin{matrix} C.Ph \\ | \\ CO.Ph \end{matrix}$$

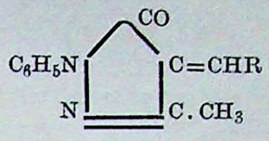
and (3) chlor-anisyl desoxybenzoin.

With piperonal and desoxybenzoin two substances were isolated, namely: (1) piperonamaron and (2) chloropiperonyl desoxybenzoin, and with p-toluyl aldehyde (1) p-toluyl amaron and (2) chlorotoluyl desoxybenzoin.

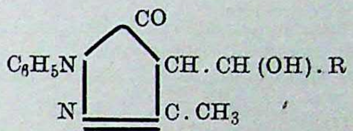
It is curious that when the hydroxy group remains free the reaction is retarded but if this is methylated as in anisaldehyde or its position taken up by a methyl group as in p-toluyl aldehyde the reaction goes on in the usual manner.

Condensation of 1-phenyl-3-methyl-5-pyrazolone with aldehydes and ketones.—*By* S. C. Chatterjee *and* B. N. Ghosh.

When 1-phenyl-3-methyl-5-pyrazolone is heated with aldehydes in molecular proportions, condensation usually takes place with the elimination of water. The compounds thus obtained have the general formula



These substances contain the chromophore -CO . C=C and are highly coloured. The present paper describes how aldehydes may be made to unite with pyrazolone, without the elimination of water, to form the intermediate additive hydroxy compounds, which bear the same relation to the compounds of the first type as aldol does to crotonaldehyde. These compounds have the general formula



The chromophoric group -CO . C=C is absent in them and necessarily they are either colourless or at any rate much less coloured than the corresponding unsaturated compounds. An attempt to synthesise pyranol derivatives from the pyrazolone and o-hydroxyaldehydes is also described.

Some new condensation products with aldehydes and ketones have been prepared, and in this connection it has been pointed out that the aliphatic ketones are much less reactive than those of the aromatic series.

Note on an alkaloid in *Argemone mexicana.*—*By* D. N. CHATTERJI.

Argemone mexicana or prickly poppy, which belongs to the natural order *Papaveraceae*, is widely distributed in India. It is known in the U.P. and the Punjab by the vernacular name Satyanashi (Sans.=satya =true, and nasha=destruction), a name suggesting that at one time it was probably believed to be poisonous. With regard to the toxic properties of the seeds, great diversity of opinion exists. While some considered them to be inert, many regarded them to have toxic properties. The various statements on the subject suggest that the toxic substance in the seeds is similar to what exists in opium, and is probably morphia. While some writers have regarded the seeds to be narcotic, no such opinion is on record with regard to the juice of the plant. Dragendorff obtained from the seeds an alkaloid which he found to agree in its reactions with morphia. My own experiments show that the seeds contain only a trace of an alkaloidal substance, a very small quantity of which can be obtained from the other parts of the plant. It thus follows that if the seeds have any narcotic properties, it is improbable that they are due to the alkaloidal substance present, as it is there only in traces. This substance, which I obtained on extracting the whole plant in yellowish-white crystals, had a bitter taste, and was alkaline in its reaction. Though behaving in some respects like morphine, it was found to differ from the latter in many of its reactions. It dissolved in cold or hot strong sulphuric acid with the almost immediate formation of a deep violet colour, which began to fade after a time. On heating the violet soon changed to blackish grey. On adding a trace of nitric acid to the sulphuric acid solution, the violet increased and then changed to grey with the simultaneous formation of a bluish-green tinge. On next heating, a beautiful sepia colour was obtained The green or the bluish green tinge with the subsequent production of sepia was found to be very characteristic of the substance under examination. The combined sulphuric and nitric acid tests may be employed for the detection of this alkaloidal principle. No other alkaloid is known to me that gives similar reactions.

The purification of Indian sesame (til) oil.—*By* H. Rai *and* H. B. Dunnicliff.

'Til' oil is used chiefly in the manufacture of soap, Indian perfumes and margarine and also as an edible oil.

The objects of the experiments undertaken were (1) to decolorise, (2) to deodorise and (3) to harden the oil by methods capable of commercial application.

Literature on the subject, beyond hydrogenisation, gives no special method for bleaching the oil.

The oil was, under suitable conditions, treated with several filtering materials, such as charcoal, bone charcoal, Fuller's earth, French chalk and the like. The effect of exposure to air and sunlight, both separately and collectively, was studied. Further, the effect of sulphuric acid and caustic soda was tried.

The following conclusions were arrived at :—

(1) Of all the filtering materials used, bone charcoal and French chalk are the best decolorising agents. All of them are ineffective as deodorisers.

(2) Exposure to sunlight alone gives progressive improvement in colour but the odour still persists.

(3) Treatment with air alone improves the colour but the odour is not removed.

(4) Exposure to both air and sunlight combined has a very marked effect on the colour. The odour, though not absent, is not unpleasant.

(5) Sulphuric acid reduces the colour very slightly, but the odour practically disappears.

(6) Caustic soda acts both as a very good decolorising and a deodorising agent.

(7) In all the bleached samples, the colour more or less comes back on standing for a long period.

(8) On heating all the deodorized samples, the odour becomes perceptible. On cooling, however, it disappears.

Note on a new method of preparing nitrogen.—*By* H. Rai.

Nitrogen gas may be readily prepared by passing an electric current through an ammonium chloride solution with platinum foil electrodes, the anode and the cathode chambers being separated by a porous diaphragm. Air is excluded from the electrolytic cell and the connecting tubes. The anodic gas is practically pure nitrogen, containing less than 0·2 per cent of oxygen. It should, however, be collected over caustic soda solution so as to absorb any chlorine gas that may possibly be mixed with it.

This affords a new and ready method for the preparation of a continuous supply of pure nitrogen.

Studies on the dependence of optical rotatory power on chemical constitution. Part I.—*By* B. K. Singh *and* J. K. Mazumdar.

Frankland in 1896 (T. 69, 1583) suggested that the order of rotatory power of position isomerides should be :—

$$\text{ortho} < \text{unsubstituted nucleus} < \text{meta} < \text{para}.$$

This theory was again revived by him in 1912 in his Presidential Address to the Chemical Society (T. *101*, 634). With the object of testing the validity of this theory, several series of new compounds have been examined; it is found that in no case is Frankland's rule borne out by these results.

The effect of conjugation on rotatory power is also studied.

Salts of porphyroxin.—*By* J. N. Rakshit.

An alkaloid, porphyroxin, has been isolated in a state of purity from Indian opium and its hydrochloride, chloroplatinate, hydrobromide, hydroiodide, sulphate, phosphate, nitrate, acetate, oxalate, citrate, tartrate, and picrate have been prepared and their properties studied.

The resolution of the systems: nitric acid—sulphuric acid—water and nitric acid—water on an industrial scale.—*By* G. S. Butler.

The theoretical considerations underlying the resolution are briefly outlined. A description is given of the manufacturing processes hitherto used for effecting this resolution, followed by an account of an experimental investigation into the processes both in the laboratory and on the large scale. The disadvantages of the usual processes are pointed out and an outline is given of the principles, based upon theory and upon the experimental results, which guided the author in designing an improved process and plant. An account follows of extensive experiments on a manufacturing scale, confirming the conclusions previously arrived at and leading up to the design of a large scale industrial plant.

An improved process and apparatus for obtaining on an industrial scale concentrated nitric acid from liquors in which this acid is present together with water.—*By* G. S. Butler.

A description is given of a process and plant which were designed with the object of avoiding the disadvantages met with in and inseparable from the retort process for concentrating nitric acid. The design and working of the plant and process are based upon the principles established in the author's first paper. The process is a continuous one and it is shown to be the most economical and efficient method of separating nitric acid from aqueous solutions of moderate concentrations and from mixtures in which sulphuric acid is also present. Notes are added regarding the concentration of sulphuric acid in the plant designed by the author and the separation of nitric acid from very weak aqueous solutions.

The diazo-transformations of amino-coumarins.—*By* B. B. Dey *and* H. Dalal.

In the course of an investigation on the orientation of the halogen atoms in chlorinated and brominated coumarins, several chloro-, bromo-, iodo-, and cyano-coumarins have been prepared by the diazo-reaction from different amino-coumarins and amino-naphtho-coumarins. Only a few of these are known, having been synthesised from the corresponding salicylaldehydes by the Perkin reaction; the yield obtained, however, was very poor, hardly exceeding 3 per cent of the possible. The process described in this paper serves as an excellent method of obtaining good yields of the products in a state of purity.

A theory of valency based on the constitution of organic compounds of the elements.—*By* P. Neogi.

The examination of the potash content of the ashes of Indian indigenous plants.—*By* P. Neogi.

The author draws attention to the fact that potash in the form of pearl ashes has been prepared in India from time immemorial by burning plants, and gives a list of the principal potash-yielding plants. The ashes of these plants have been analyzed and their potash content determined with a view to their use for the manufacture of potash during the war.

The enolisation of carbonyl compounds under the influence of Grignard's reagents.—*By* V. K. Bhagvat *and* J. J. Sudborough.

In 1904 Hibbert and Sudborough showed that an amyl ether solution of magnesium methyl iodide produces considerable enolisation in the case of ethyl acetoacetate, the volume of methane measured corresponding with a 90 per cent content of the enol form.

The action of the same reagent towards various aldehydes, ketones and ketonic esters has been studied by determining the volume of gas evolved. Most ketones and aldehydes behave normally and yield only small amounts of gas. Ketonic esters and β-diketones, on the other hand, yield large volumes of methane showing that appreciable enolization occurs. The following substances have been examined :—acetone, methyl propyl ketone, methyl *iso*propyl ketone, methyl butyl ketone, phenyl benzyl ketone, *p*-tolyl benzyl ketone, allylacetone, chloral, propaldehyde, *n* butaldehyde, *iso*butaldehyde, *iso*valeraldehyde, cinnamic aldehyde, ethyl benzoylacetate, ethyl acetosuccinate, benzoylacetone, acetylacetone.

The manufacture of glycerine by means of castor seed lipase.—*By* J. J. Sudborough, H. E. Watson *and* P. S. Varma.

The authors have studied the action of castor seed lipase on cotton seed oil with the object of obtaining the best condition for using the process for the manufacture of a crude glycerine in India. Experiments based on the French, German and Japanese patents have been made. These experiments show that a concentrated crude glycerine, which compares favourably with undistilled Twitchell glycerine, can be obtained by using a modification of the French method.

Details of methods of treating the oil and the catalyst, and of the preliminary refining of the sweet liquor before concentration are given. Questions of optimum temperature and of co-ferments are discussed.

The authors are of the opinion that the castor seed lipase method should be able to compete with the Twitchell process for the manufacture of glycerine and of free fatty acids for use in soap and candle-making.

Adsorption of hydrogen by quartz at low temperatures.—*By* G. R. Paranjpe.

These experiments are carried out with an apparatus, which is specially designed for the purpose, and which is based on the principle of the differential manometer. The small irregularities of pressure, resulting from the unequal magnitudes of adsorption in the two bulbs on both sides of the manometer, are measured by effecting certain volume changes necessary to re-establish the equilibrium. These changes are effected in a calibrated compensator attached to one of the bulbs.

It is shown that the principle, on which the successful working of the apparatus is based, does not depend on the knowledge of the equation of state of the gas under investigation and it holds to the first approximation for any gas law.

The measurements are made at the temperature of liquid air, viz. −190°C and at various pressures between 25 mm. and 350 mm., the quantities of hydrogen adsorbed, at these extreme pressures, by 100 sq. cm. of quartz surface, and reduced to N.T.P., being 2·0 c.mm. and 10·5 c.mm., respectively.

It is observed that at extremely low pressures there is a finite adsorption of 2 c.mm., and it is suggested that this effect is similar to the effect of fixed adsorption in the case of charcoal.

The results of these experiments are used in the calculation of the necessary correction to a hydrogen gas-thermometer, made out of quartz: and it is pointed out that even at the temperature of −190°C the magnitude of the correction is very small.

Similar experiments are being continued on nitrogen and other gases and at various other temperatures.

A note on the adsorptive power of cocoanut charcoal.—*By* H. E. Watson.

Experiments have been made to determine the amount of gas adsorbed by samples of cocoanut charcoal made at various temperatures.

An apparatus has been designed suitable for a rapid test for commercial purposes.

It is found that the adsorption of a given weight of charcoal increases with the temperature at which it is made, that is to say it increases as the quantity of volatile matter decreases.

Derivatives of gallic acid—preliminary note.—*By* R. L. Alimchandani *and* A. N. Meldrum.

Section of Zoology and Ethnography.

President—F. M. Howllet, Esq., *B.A.*, *F.E.S.*

Presidential Address.

POST-WAR ZOOLOGY.

(With Plate I.)

I feel, as I stand here and try to look as much like the President of the Section of Zoology and Ethnography as possible, very much like an impostor. For I have been engaged for a long time on work in one particular department of Zoology, a department moreover which is perhaps more open than most to the criticism that it is unduly water-tight, that department which deals with insects—and I am afraid that I am not competent to prophesy anything with regard to the probable future tendencies of zoology as a whole.

About "post-war Zoology," then, you know at least as much as I can ever pretend to do, but it is a subject which is of such great practical importance—as we already know from Col. Glen Liston's address—that discussion of it is by no means futile.

There is one remarkable modern development of the study of animals—and especially of man—which can hardly fail to hold one's attention. I mean the development of the idea that underlying the morphological characters of an organism there is another set of no less definite chemical characters. That each order, family, genus, and species has an individuality quite apart from that which we have in the past made the basis of our zoological classifications.

That is to say, a definite chemical personality, as definite in its way as that complex of morphological and psychological characters that goes to form our ordinary every-day concept of a mouse or an elephant.

If the bodies of different animals are analysed, or if particular organs or tissues are analysed, they are found to be by no means of the same composition in different genera; and the same holds when the chemical behaviour of tissues is examined —such as the absorptive power of the blood for oxygen, or the action of the excretory organs.

Mammals, for instance, get rid of their nitrogenous waste-products in the form of urea, whereas in the Selachians there is a remarkable amount of this substance in the blood. Birds and reptiles excrete nitrogen not as urea but as uric acid, while among invertebrates there is a great variety of methods; insects for example may get rid of nitrogen in the form of chitin, uric acid, or substances akin to guanine, to mention only three, and possibly in other ways that are not yet known, as very few cases have been examined.

These chemical personalities of different species, though they may be indistinguishable to our unaided senses, are undoubtedly distinguished by many parasites with the utmost clearness. There are innumerable cases where animal parasites, external or internal, confine their attention to one species, or to a group of nearly related species. Bird-lice or tape-worms are good examples, and the same thing is seen in the vast number of insects that infest only one kind of plant or a few closely related plants.

You will however be familiar with one very striking way of revealing these chemical personalities to human eyes. I mean those precipitin-reactions recently so much developed by medical workers, and the various allied phenomena of blood-chemistry whereby the degree of chemical relationship between organisms may be tested.

The serum of a rabbit, for instance, treated with human serum will give a precipitate with the serum of anthropoid apes, but not with that of other mammals including the lower monkeys. If the rabbit serum be treated with that of a frog *Rana viridis*, it will give a precipitate with serum of *Rana fusca*, but not with that of a tree-frog or a toad. Similar reactions hold with invertebrates, and my present purpose is merely to recall to you the fact that there exists here a whole world of undiscovered things. That organisms have a chemical personality underlying the morphological, and that the chemical personality is of the two infinitely the more important from the practical point of view which concerns itself with the activities of the organism rather than with its appearance.

I will take as exemplifying this importance what seems to me to be the chief problem of applied zoology, and in particular those departments of it that deal with measures against harmful animals, and more especially against insects.

It is often assumed that the aim of the practical Biologist, the Mycologist, the Sanitarian, the Medical Officer, or the Entomologist, who may have to deal with harmful organisms such as fungi or insects, is the destruction or "eradication" of the plant or insect that is doing damage.

But this destruction of the noxious organism, though of the greatest importance, is in the strict sense only a secondary aim, being merely the most satisfactory and lasting method of *preventing contact*. In reality, the prevention of contact is our primary aim. No one minds a caterpillar, for example, so long as it does no damage to certain particular plants we are fond of; and if it would refrain when asked to do so from eating them, I am sure no tender-hearted person would think it necessary to kill it as well. If I may make a short digression, I might remark that whatever may be said of our general administration of this country, our judicial system has in certain areas compelled an unusual degree of respect. In certain parts of Bihar, when a crop is badly attacked by caterpillars, the local priest posts in the field a proclamation which is couched in the correct official terms and language of the courts, solemnly calling upon the caterpillars to desist from their turbulent conduct, and warning them to disperse and go to their homes within a specified period, on pain of severe penalties.

Probably the proclamation is as often as not effective, and the fact that the caterpillars—by the end of the specified period—may have fed themselves up, gone into hiding, and pupated, need not detract from our appreciation of the testimonial to the effectiveness of our legal methods. The proclamation clearly recognizes the fact that prevention of contact is the essential thing—to prevent the caterpillar from coming into effective contact with the crop, in other words from eating it.

In the case of almost all insects "effective contact" means not merely bodily contact but *feeding*. And feeding implies not merely the mechanical contact of the body, jaws, and so forth, with the surface of the victim, but also—and this is equally important—what one may call a "psychological" contact: a recognition that the victim is good to eat.

To us human beings, alert and receptive as we are, guided in our every action by the light of pure reason, never absent-minded, and accustomed to eat what to a caterpillar or a mosquito would seem the most amazing and repulsive collection of foodstuffs, it may seem a little pedantic to insist on the necessity of food-recognition.

But an insect has often to confine itself to a particular diet with a strictness that no human doctor would ever insist upon; often indeed it cannot live upon any other food than one very special kind, often one particular plant or small group of related plants, and will actually starve rather than try something else which does not show the proper recognition-marks.

Some years ago I compared insects in general to human beings in the condition commonly known as a hypnotic trance. A person in this condition may follow out with the utmost concentration a certain set of instructions, but be almost oblivious of anything which does not come within the prescribed circle of ideas. And so it seems to be with insects; there are certain instructions, so to speak, as to how to recognize food, where to lay eggs, and so on, and they are followed. The more narrowly precise and definite the instructions (i.e. the more specialized the insect and the deeper its "trance") the greater the concentration with which they are obeyed and the greater the penalty of error.

In defining effective contact we must then take recognition as a definite factor. It is necessary for an insect to recognize its food and also to be in sufficiently close bodily contact with it.

But "an insect" may be all sorts of different things at different periods of its life; the caterpillar, for instance, was hatched from a harmless egg and will turn into an equally harmless chrysalis and then a perfectly charming butterfly, all quite incapable of damaging plants. No one is afraid of a plague-flea's egg, or of an Anopheline larva so long as it remains a larva. That is not the time at which it is dangerous.

We see then that if an insect is to make effective contact with its victim it must fulfill three conditions: it must be in both bodily and "psychological" or sensory contact with it, and must also be in what we might call "temporal" contact; i.e. at the right time, the right period of its own and the victim's development.

And now, having got these three essential factors, bodily contact, sensory contact, and time-contact, it seems to me that we can profitably use them to construct a model of the relations between an animal and its food, or a parasite and its host; and although this model must, owing to our ignorance of many important matters, be very incomplete, it will at least have the merit of being something tangible, something one can look at and think about and criticise.

Let us take a simple case, a plant, say a "hardy annual," and consider the extent of its mobility, its bodily range of motion in space. We may assume that the only time it exhibits any appreciable mobility is at the season when it expands its range by scattering its seed, and for the rest of its life its mobility or power of expansion—excluding a certain growth of roots and branches—is nil.

We might then represent it by this curve, showing the variation of its mobility with time. (Fig. 1.)

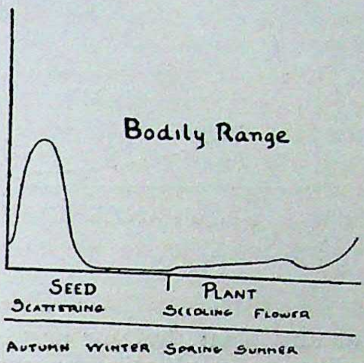


FIG. 1.

Now let us suppose that the flowers of this plant have a very attractive scent. We can then represent its attractiveness by another similar curve, a "smell-curve." (Fig. 2.)

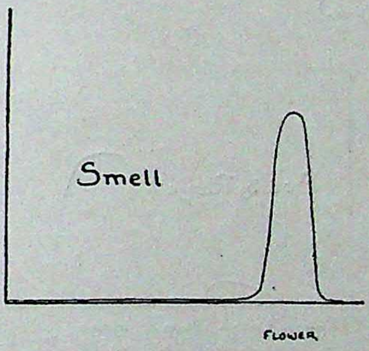


FIG. 2.

Now if we assume that the intensity of a smell diminishes more or less as does the intensity of light, inversely as the square of the distance from its source, its diminution with increasing distance will follow a course like this, taking the origin as being the source—the flower. (Fig. 3.)

Then by combining these three curves we get a solid form showing the bodily and sensory extent of the plant at different periods of time, assuming for the sake of simplicity that only the flowers are attractive, and that they owe their attraction entirely to their nice smell. (Pl. I, fig. 1.)

I have taken the case of a plant because it is relatively simple, but you will readily see that we could construct similar forms not only for any plant, but for any animal, and also that these forms will vary greatly in appearance and exhibit curious and characteristic shapes for different organisms.

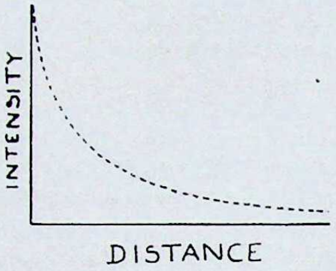


FIG. 3.

And now let us introduce the villain of the piece, the animal who feeds on the plant. We will suppose it is an insect, say a beetle, who is accustomed to eat the flowers and to find them from a distance by their smell.

This curve shows his power of range, or mobility, at different stages. (Fig. 4.)

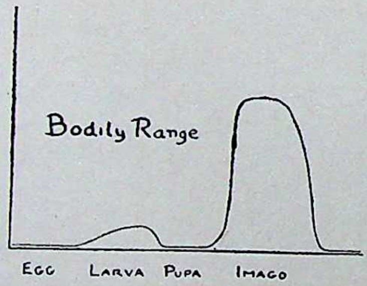


FIG. 4.

The immobile egg, hatching into a grub which we will suppose to burrow in the soil and have a limited range; then the immobile pupa, from which emerges the winged beetle with considerable range of movement.

So far we have treated the beetle like the plant, but on the sensory plane it is obvious that we are not practically interested in the attractiveness of the beetle, since this doesn't affect his relation with the plant. What we want to know is something about his susceptibility to the plant's attractions, the delicacy of his perception of the smell of the flower.

Now you know that with ourselves any stimulus, such as a smell, a light or a colour, a sound, a touch, or a taste, has to be of a certain strength before we are able to perceive it at all. Its intensity has to rise above a certain minimum height if it is to pass the threshold of our consciousness, and the height of the threshold varies in different people and at different times. The lower the threshold, the more delicate the perception.

So instead of plotting the beetle's attractiveness we will represent the variations in the height of his sensory threshold for the smell of the flowers on which he feeds.

Just as the seed of the flower had no attraction, so we may take it that the beetle has no perception of flower-smell when he is an egg, or even when he is a grub or a pupa; he is occupied then with other matters, and flower-smells will have to pass a very high threshold before they can penetrate to his consciousness.

But the height of the threshold will drop abruptly when he enters the final winged stage of his existence, wherein he depends on the flowers for food. Two things will then chiefly interest him—finding his proper flowers, and finding a mate: but if we omit the complications associated with the latter pursuit, we can represent the varying of his flower-smell threshold by a curve like this. (Fig. 5.)

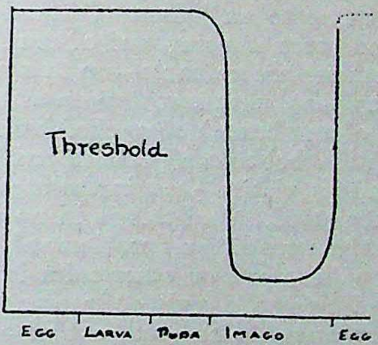


FIG. 5.

It shows the intensity of the stimulus that he is able to perceive at different periods of his career. His attention will not be engaged by any smell whose intensity falls below the line.

You will see that this means that the beetle cannot make effective contact unless his range of mobility extends at least to this point. (Pl. I, fig. 2.)

Then it will be clear that if this point is a little beyond the average mobility of this kind of beetle, only exceptionally active beetles will be able to find food, and the species as a whole will decline in numbers. If on the other hand the point of sensory contact lies within the normal beetle's range in space, then the species will increase up to the limit of the food-supply. There will in fact be a correlation between an insect's range in space, its sensory threshold, and the period of its life-cycle. Moreover, we can use our model in considering the practical measures to be adopted against insects or other noxious animals; for if the model is made on sound lines, we ought to be able to fit these practical measures into three categories—Prevention of space-contact, sense-contact, or time-contact: and if you look into the methods of applied biology you will find, I think, that they do fit into these categories, or combinations of them, in a very interesting way.

But my immediate purpose in putting this model before you is not to discuss the deductions we might make from it, but to lure you into a particular criticism. You will probably have noticed that for the purpose of explaining the model I took, not the case of a real plant and a real beetle, but imaginary plants, imaginary curves, and imaginary beetles. And the reason is a very simple one: I had to.

For many years insects have been studied far too much as static organisms. Their external form and the bare facts of their life-history have been recorded, and undignified wrangles have occurred on the burning subject of who first gave some particular name to an insect. Certainly the wrangles, though undignified, were amusing, and of course morphological and life-history studies are valuable—up to a point. But it is a remarkable fact that what is really one of the most fundamental problems of any branch of applied biology,—the actual nature of the relation between a parasite and its host, a noxious organism and its victim—has, in the case of insects, been almost entirely neglected. And this is in no way an isolated case. For in all the more difficult problems of Applied Zoology, whether we deal with insects or other animals, we are continually being checked by a solid wall of ignorance, because these more difficult problems in nine cases out of ten resolve themselves into questions which cannot be answered save by an appeal to the chemist, the physicist, the physiologist, or the student of comparative psychology.

The ordinary zoologist, protozoologist, helminthologist, entomologist, fishery expert, or mycologist, is not able to answer these questions, any more than the ordinary medical man; and if we are ever to attain to an effective control of noxious organisms, and in particular to an effective and economical control of insects based on some real understanding we must frankly recognize that entomology alone, as ordinarily understood, is unequal to the task. It has indeed proved itself unequal. The war has done many things. It has let the cold

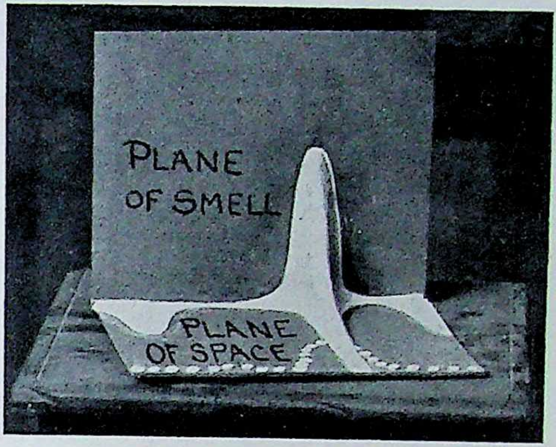

PLANE
OF SMELL
PLANE
OF SPACE

Fig. 1

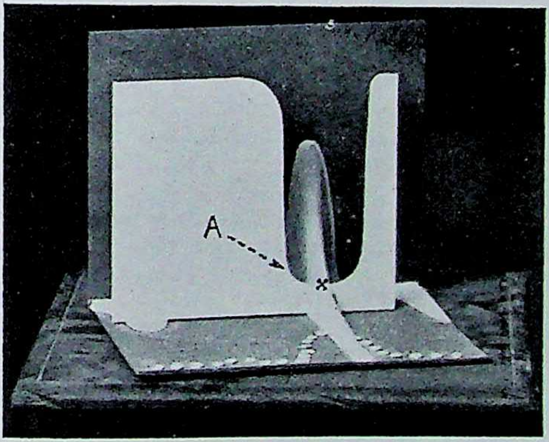


Fig. 2

wind of reality play upon many of our cherished opinions and beliefs, and one of the beliefs that has wilted under the blast has been the belief that entomology, as generally practised and understood in England in the past, was competent to meet the practical demands of a big campaign. In the past three years I have had the privilege of being in charge of some of the entomological research carried on by the War Office at home, in response to demands from various fronts, and my experiences during that time brought home to me, as nothing else could have done, the extraordinary neglect of those departments of entomological research which might be expected to help us in solving the problems of insect-control, and our remarkable ignorance, even in the case of the commonest insects such as the house-fly, the louse, and various mosquitoes, of those facts of physiology and psychology which must be the ultimate basis of preventive and destructive measures against them.

Such measures, if they are to be scientific—in other words, if they are to be efficient and economical—must be based on knowledge. And that knowledge must be something that goes deeper than merely knowing the main facts of an insect's life-history and habits. Often it will only be supplied by the chemist, the physiologist, or the comparative psychologist, and the recognition of this fact constitutes our main hope of future progress.

In the war that is coming, the war against insects, we must enlist these men in our ranks, and realize that no one department of science—and in particular no one department of zoology—can be, from the practical point of view, efficient if it tries to stand alone.

The varieties, geographical distribution and ethnological significance of outrigger canoes.—*By* J. Hornell.

Outrigger canoes and boats are divided into two main types—double and single outriggers. The latter are the more varied, the main variations having very definite distribution. An attempt is made to prove that single outriggers are more primitive than the double form, which is confined entirely to Indonesia, the north-west of New Guinea, and to Madagascar, the Comoro Islands and the East African coast. The early Indonesians or Malaysians as they may more properly be called, appear to have invented this type. In their hands the outrigger reached very high development as proved by the Boro Budur sculptures of the 8th and 9th centuries of our era, where two-masted outrigger ships, with compound masts, high superstructure such as the outrigger design permits, and with two quarter rudders, are depicted in numerous beautiful panels. Centuries must have been passed in the acquisition of the requisite ship-building skill to put together such great and complicated vessels. There is little doubt that before the Christian era the Javanese were expert deep-sea navigators. That they owed nothing to the Arab and the Indian is reasonably certain. Double outriggers have never been used in India so far as all evidence goes. This knowledge gives the key to the puzzle of how the ancestors of the Malagasy tribes of Madagascar arrived wave after wave in that island. In great ships of the Boro Budur type this long voyage is neither difficult nor dangerous in the fine weather season.

The distribution of single outriggers lends weight to my hypothesis that the Polynesians at one time occupied many of the Indonesian islands lying between the Papuasian region and the Asiatic mainland; this archipelago at a later period was invaded by a Mongoloid people, the proto-Malaysians who partly absorbed and partly expelled the Polynesians. The more enterprising of the dispossessed fled west and east taking their single outriggers with them; the western section drifted to the Indian and Ceylon coasts, or took refuge in the islands off the west coast of Sumatra (the Mentawei islanders); the others passed to the myriad islands of the Pacific where considerable mingling with the Oceanic Negroes took place in certain island groups. That the Polynesians have been long settled in the chief main Pacific islands other than Hawaii and New Zealand, is proved by the great divergence in design met with in different areas. *New Guinea is however the focus of all these designs;* their geographical distribution when plotted on a map shows that all the principal forms radiate fan-like from New Guinea.

A peculiarly interesting point to note with regard to the rig of Indonesian and Papuasian outrigger canoes is that the sail used is usually an antique form of balance lug of oblong rectangular form fitted with bamboo poles along each long side; the same peculiar rig was employed in the Boro Budur ships, and it is this sail, absolutely different alike from any modern Arab or Indian design and from any used by the ancient Egyptians, Phoenicians and Greeks, that the Hamitic and negroid boatmen employ in the naggars of the Upper Nile. These men row standing as in the some parts of the Far East, and these two facts together with the presence on the Swahili coast of outrigger canoes of Indonesian affinity, point suggestively to a connection between East Africa and Indonesia in far-off days, much stronger than has hitherto been suspected.

The significance of the oculus in boat decoration.—*By* J. HORNELL.

The earliest known occurrence of the oculus placed on either bow of boats, is on the funeral barges of the ancient Egyptians, where it symbolized the eye of Osiris under whose guidance the spirits of the dead should be conducted to their eventual home. The Romans and Greeks habitually placed it upon their galleys; thereafter its use gradually fell into disuse; survivals are still to be found on the Portuguese, Italian, Dalmatian and Greek coasts and in Malta. No Muhammadan boat-people use the symbol, neither Arabs, Indian Muslims, nor Malays. Among the Chinese and Annamites, the custom of placing eyes on the bows is widely prevalent; the Chinese use a round boss-like form; the Annamites, a greatly elongated or almond-shape. In India and Ceylon employment of the oculus is rare and is limited to Hindu boat-people. Three instances are described—(*a*) Ganges cargo boats, in the neighbourhood of Benares chiefly, (*b*) the "Kalla dhoni" of the Point Calimere neighbourhood (S. India), and (*c*) "Jaffna dhonis" from Velvettithurai in the north of Ceylon. The crews of all these craft practise religious rites more elaborately than usual; the bow is the place where puja is done; the details described compel the inference that the presiding deity of each of these boats has her habitation at the prow, installed there during the ceremonies attendant upon launching, and that the eyes on the bows are symbolical of the presence of this protecting spirit, and of her efforts to guide the boat safely from haven to haven. Female deities are specially linked with the protection of Indian boats; probably this is a survival of a once universal belief and accounts even for the English habit of considering all vessels as feminine.

The custom of employing the oculus in India was probably widespread in former times; two boats figured in the Ajanta frescoes show it distinctly. Another old instance dates back to Buddhist days in Java; one of the Boro Budur sculptures depicts a two-masted ship bearing this decoration.

The study of fresh-water Ciliates in India.—*By* B. L. BHATIA.

Neglect of the study of fresh-water Protozoa in India.

Previous record of fresh-water Ciliate protozoa from India, based on the work of Carter and others.

Methods of research briefly described.

A new method of slowing the movements of rapidly moving forms.

Record of genera and species, most of which, it is believed, are recorded for the first time from any part of India, with brief notes.

Notes on the life-history of two fishes—*Callichrous bimaculatus*, *Bolch* and *Notopterus notopterus*, *Pallas*.—*By* C. R. NARAYAN RAO.

The paper suggests the possibility of the occurrence of more than one local race of *Callichrous bimaculatus*, as the differences on which the view is based are more than individual variations. In the developmental history of this fish a continuous anal fin with the caudal which is entire is a noticeable feature as the same is a permanent adult character in *C. sindensis* and *C. gangeticus*. Certain examples of *Notopterus notopterus* that were locally obtained appeared to be crosses between *Notopterus* and *Chitala* and the variations are indicated. The eggs of *Notopterus* adhere to each other and to the substratum on which they are deposited in small clumps, and the development of the more interesting morphological characteristics is recorded.

A revision of the genus Phyllobothrium with special reference to the species recorded from Indian fishes.—*By* T. SOUTHWELL *and* B. PRASHAD.

These cestode parasites for the most part inhabit the spiral valve of selachians. Only five species have as yet been recorded from Indian fishes and these are dealt with in detail. Interesting and important additions are made to our knowledge of the anatomy and distribution of the Indian species.

Intra-uterine embryos of Indian Selachians.—*By* T. SOUTHWELL *and* B. PRASHAD.

In this paper the authors, after describing the various modes of oviparous placental and aplacental viviparous reproduction amongst the Indian elasmobranchs, trace the evolution of the various modes from the simplest oviparous to the more complicated viviparous types. The question of the evolution of the various types is very interesting owing to the occurrence of the different types amongst the living elasmobranchs and the importance it has on the question of their relationships.

In the second part the structure and evolution of the different types of placenta, the placental cord and its appendages as found in the placental viviparous forms is treated of in detail. The structure and function of the branchial filaments is also described.

A short note on the distribution of a recently-described genus of fish.—*By* B. L. CHAUDHURI.

Over six years ago I came across some very interesting forms of fish in the Family *Cobitidinae* from the Dibang river and its connected streams on the N.-E. Frontier of Assam which I described under the name *Aborichthys* (Rec. Ind. Mus., VIII, p. 245). The collection was made by Mr. S. W. Kemp, who subsequently obtained some similar specimens at Tura (Garo Hill, Lower Assam). Very recently I have found two fish almost like them in the collection made by Dr. Murray Stuart from Putao Plain (H. Kamti Long) on the N.-E. Frontier of Upper Burma as already noticed by me (Rec. Ind. Mus., XVI). Though at first I thought the fish from Upper Burma to belong to the same species as those from the Debang river system and Tura, I now find that they belong to a very distinct race, if not altogether a different species. The rivers and hill streams of Putao Plain belong to the Irrawady system, and one quite separated by very high mountain ranges from the watershed of the Brahmaputra system including the Dibang and the Lohet of Upper Assam. The fish from Tura (Garo Hill) belongs to a race closely similar to those from Abor land, but both are more or less distinct from those of Putao Plain. Thus the distribution of this recently-discovered genus becomes very interesting and is comparable to the distribution of the well-known genera *Licassis* and *Semiplotus*.

The development and breeding habits of a brackish water polychaet worm from Madras.—*By* R. Gopala Aiyer.

In the piece of backwater near the Volunteer Guards Rifle Range on the road to Adyar, a number of pear-shaped stalked spawn masses can be observed almost throughout the year. They are very numerous during the hot season, less so during the rainy months. Some of them are very big, and all of them have their stalks running down into the mud where each one becomes continuous with the burrow inhabited by a polychaet worm of the genus *Marphysa*. The masses contain large numbers of eggs and young larvae. It is suggested (*a*) that the jelly affords protection to the eggs from the sun's rays when the tide runs out and leaves the masses exposed ;

(*b*) that the jelly affords a comparatively safe place of development during the initial stages ;

(*c*) that the jelly prevents wide dispersal of the larvae, i.e. adaptation to backwater conditions.

A trochophore stage is absent. There is however a prototrochophore followed by metatrochophore and nectochaeta stages. The first two stages are passed inside the jelly, the third stage outside it, creeping at the bottom. A free swimming stage is absent, probably on account of the greater part of the early development being passed in the jelly.

The development and differentiation of setae are interesting. In very young worms three kinds of setae can be observed: capillary unjointed setae, compound setae with a short terminal blade, and compound setae with a moderately long terminal blade. The last kind, it is suggested, is derived by the elongation of the terminal blade of the second variety. In adult worms obtained by digging from the clay, compound setae with a short terminal blade are not found at all. Unjointed capillary setae and falcigerous setae are found in the anterior segments, and only capillary in the posterior. This final condition is reached very late. The worms grown in the laboratory from eggs up to a late stage develop compound setae with a short terminal blade, and capillary setae in the newly-formed segments. But the terminal blades of the compound setae elongate, bringing about the falgigerous condition. When more than a hundred and fifty segments have been formed the formation of the compound setae is given up and capillary setae alone are developed at the posterior region. Thus fixity of setose characters is attained late.

Larval eyes disappear and their place is taken by a pair of adult eyes. The tentacles are peculiar in appearing very late. The median tentacle, which is the first to appear, arises only when 18–20 pedigerous segments have been laid down. This is followed a day later by the appearance of the intermediate tentacles. The lateral tentacles appear last, only when about 80 segments have been formed. This belated development of the tentacles is interesting as it is in strong contrast to their early appearance in the larvae of other polychaets.

The larvae were kept developing for over 6 months and during this period the number of segments developed was about 170. Judging from this it is inferred that growth in these worms is very slow and that worms dug up from Adyar having as many as seven hundred segments must be at least 3–4 years old. Of course it may be urged against this that the slow growth in the laboratory is due to abnormal conditions.

A full description of the Adyar worm is given and some of the individual variations in the gills also noted.

On a new type of Annelid excretory system in earthworms.—*By* K. N. Bahl.

The two types of excretory systems recognized in Annelids are the "meganephric" and the "plectonephric." In the earthworm investigated (*Pheretima posthuma*) there is a distinct third type which I have called "alimentary" since the important feature about this system is that the ducts of these nephridia do not open to the exterior, but into the alimentary canal all along its length. The terms "diffuse" and "plectonephric" are clearly inapplicable to the excretory system in this earthworm since there is no network anywhere in the system.

The elaborate system of ducts connected with these nephridia, and never noticed before so far as I know, consists of a pair of septal excretory ducts on each septum and a pair of supra-intestinal excretory ducts situated below the dorsal vessel. It is these ducts that communicate segmentally with the lumen of the gut.

The construction of calcareous opercula by longicorn larvae of the group *Cerambycini* (*Coleoptera. Cerambycidae*).—*By* C. F. C. Beeson.

Species of longicorn larvae of the group *Cerambycini* close their pupal chambers with deposits of calcium carbonate secreted in the Malpighian tubes. The deposits take the form of variously-shaped opercula or of a complete internal lining of lime, to which is sometimes added a film of chitinous material.

The opercula of the genera *Aeolesthes*, *Derolus*, *Dialeges*, *Diorthus*, *Hoplocerambyx* and *Plocaederus* are described and the method of construction outlined.

Suggestions are put forward to explain the object of the opercula. The possible objects are (*a*) protection against natural enemies, parasites and predators, (*b*) protection against intrusive moulds and parasitic fungi, and (*c*) maintenance of an average degree of relative humidity inside the pupal chamber. A consideration of the life-histories of the insects and of their food plants indicates that the last object is the most important. It is further suggested that the species which are normally borers in soft woods completely line the pupal chamber with lime, and that species which are normally breeders in hard-woods restrict the lime deposit to a cap-shaped operculum.

The life-history of a midge, *Culicoides* (*oxystoma* ?), with remarks on the early stages of *Ceratopogon*.—*By* P. G. Patel.

Very few observations have previously been made on the bionomics of Indian midges. The eggs of some four species of Culicoides (including

C. kiefferi and *C. oxystoma*) are of a curiously elongated form, not oval as previously described for *kiefferi*. Those of *oxystoma* hatch in from 3–11 days according to weather. The larvae are legless and smooth, moving in serpentine fashion in early life, but later acquiring a vibratile motion, and breathing by gills of characteristic shape in the different species. Pupation in 10–40 days, the pupal period lasting 4–7 days. The adults have a characteristic habit of sitting with head downward and pressed close to the supporting surface. The females (only) bite by day and night, greatly distending themselves with blood. Eggs are laid in the washings of stables, though all other species observed breed in algal growth.

Some points of comparison between the larvae and the biting habits of *Culicoides* and *Ceratopogon* are indicated.

A note on the effects of Mercurous Chloride on Culicid Larvae.—*By* S. K. SEN.

Exceedingly small doses (1 in 10,000) of mercurous chloride have a remarkably deleterious effect on the larvae of Culicidae, death occurring within 12 to 18 hours. Figures are given for different proportions of the salt in relation to varying quantities, depths and surface areas of water. Its poisonous effect is compared with that of mercuric chloride and other halogen salts of the metal. From the results obtained it is concluded (1) that its action is not of the nature of osmosis, because of its small solubility (0·002 in 1 litre) and because a saturated solution of the salt had no effect; and therefore (2) that the suspended undissolved particles of the salt act through the mouth, or cutaneously, or both.

A preliminary note on the action of acids, salts and alkalies on the development of culicid eggs and larvae.—*By* H. N. SHARMA.

These experiments consisted in placing eggs of *Culex* in solutions of various strengths and noting the effect on (1) hatching, (2) rate of development of larvae, pure water being used as a control.

Marked differences were found in the action of the salts, several—especially the citrates and tartrates—increasing the rate of development in a very noticeable way. The chemicals employed were :—

Acids—Tannic, salicylic, boric, citric, malic, butyric, acetic, lactic, tartaric, oxalic, sulphuric and hydrochloric.

Salts—Mercuric chloride. Potassium permanganate, Sodium nitrate, Sodium chloride, Potassium chloride, Sodium phosphate, Sodium sulphate, Sodium thiosulphate, Potassium bitartrate, Sodium tartrate, Sodium citrate, Sodium oxalate, and Potassium citrate.

Alkalies—Sodium hydroxide, Potassium hydroxide, and Calcium hydroxide.

On some *Trichonymphae* of the intestine of *Leucotermes indicola*.—*By* F. DE MELLO.

The author places before the Congress the results of his studies on some parasites of *Leucotermes indicola* Wasm, belonging to the genera *Trichonympha* (Leidy 1877) and *Leidya* (Franca 1914). In the present paper, the first of a series of memoirs dealing with the parasites of Indian Termites, special reference is made to the original description of Leidy, and the figures represented in his plate 51, as belonging to *Trichonympha agilis*, and it is shown that only the figures 1–10 (although incorrect) can be accepted as of *Tr. agilis*. Leidy has made some mistakes in his studies of *Tr. agilis*, and these mistakes have been spread by text-books on Protozoology which illustrate their descriptions with figure 10 of Leidy's paper.

The author gives a detailed description of the morphology and methods of multiplication of the parasite, confirming as regards the latter the observations of Foa in Italy; and as his description differs totally from that of Leidy, excepting in what concerns the movements of *Triconympha*, and in some points from those of more recent authors as Franca, Ray Lankester, their descriptions are quoted and criticized.

Franca has created the genus *Leidya*, and maintains that the so-called young stages of *Triconympha agilis* or immature parasites have nothing to do with *Trichonymphae*, a fact already noted by Butschell. *Leidya metchnikowi* (Franca 1914) has been found in the rectum of *Leucotermes indicola* and the author shows that the figures 11–22 from Leidy's paper belong to the genus *Leidya.* Two new species are described and named *Leidya annandalei* and *Leidya kempi.*

Finally a study is made of the bodies contained in the endosarc of *Triponymphae.* The phagocitism by *Trichonympha* of young *Leidya* is shown and some of the forms seen are of the same nature as the nuclei of *Leidya.* Another interesting parasite infests the *Trichonymphae*; the nature of this parasite requires further investigation, but it is probable that some of the so-called masses of spores described by Leidy have some relation to this parasite.

The reproductive habits of *Etroplus suratensis.* *By* N. P. PANIKKAR.

1. The fish breeds twice a year; in May—June and in October—November; becomes sexually mature at the second year.

2. Breeding takes place at shallow shady places on the bottom of fine sand and mud in back waters, brackish ponds and canals and in fresh-water rivers as far as tide limits.

3. Spawning takes place generally at the beginning of both the Monsoons.

4. The male fish prepares surface for the attachment of the ova and also the larval nest, the latter by excavating small pits by taking the mud in the mouth and throwing it away.

5. The newly hatched larvae attach themselves to the egg membrane for a short time, whence they are removed to the pit by the male by taking them in his mouth, a habit similar to the breeding of the young in the pharynx observed in the congeneric species of Africa. If disturbed they are removed from one place to another by the same process. This habit is observed in the case of *E. Maculatus* also.

6. The female broods over the eggs and the larval nest is guarded by both the parents, especially by the male who defends the nest from intruders.

7. The eggs hatch on the fourth or fifth day. The larvae remain in the nest for about seven days and then leave it. They are then taken about by the parents in quest of food. The adult form is reached only about a month after hatching. The ocellus then appears on the soft rays of the dorsal fin which gradually fades away after four months.

8. Member of the same species, *E. Maculatus* and gobies are the most common enemies in the larval stage of the fish.

9. The young chiefly feed on minute animal life. Vegetable food is taken only after reaching the adult form.

10. Two forms of larvae are distinguished; one with a round yolk sac in which a dilatation appears at the cardiac region when the yolk sac is half absorbed; the other with a more or less oblong yolk sac in which no such dilatation appears.

Section of Pure Botany.

President—S. R. KASHYAP, ESQ., *M.Sc.*, *B.A.*

Presidential Address.

THE RELATIONSHIPS OF LIVERWORTS ESPECIALLY IN THE LIGHT OF SOME RECENTLY DISCOVERED HIMALAYAN FORMS.

The new light thrown on the general trend of evolution in the Liverworts by my investigations of the Himalayan forms of that group and the very important position generally assigned to this group in a scheme of evolution of the Vegetable Kingdom have induced me to select this subject for my address to-day. The study of Liverworts has an importance which is not restricted to this group alone but has an important bearing on the origin of the higher plants and it is this aspect of the question which I want to emphasize to-day. My object is not to trace the relationships of all the genera or even all the families of Liverworts but to point out the bearing of certain forms on the course of evolution within the group and thus to come to some conclusion as to the true position occupied by these plants in the Vegetable Kingdom.

The significance of these Himalayan forms has been very recently emphasized by Professor Goebel in the second edition of his Organographie der Pflanzen. I am also particularly glad to select this subject for my address to-day as it affords me an opportunity of emphasizing the great value of the study of Indian Cryptogams which have not so far received the same attention from Indian botanists which the flowering plants have and which they so richly deserve.

In order to realize fully the importance of the position of Liverworts in a scheme of classification of the Vegetable Kingdom we have to bear in mind that they form an intermediate group between the Algae on the one hand and the Pteridophytes on the other as regards the complexity of their structure and the differentiation of their organs. No one maintains, however, that there is a regular series of forms in an ascending order of complexity from the Algae to the Pteridophytes through this group, for there is a great gulf on either side which remains still unabridged even after many intensive and extensive studies of the different groups by numerous investigators. Some ingenious hypotheses have been proposed and plausible hypothetical forms have been assumed to bridge these gaps, but it must be said, so far without any success

The evidence in tracing relationships is derived chiefly from the comparative morphology of living and extinct plants and it is supplemented to some extent by facts supplied by the study of development. If we could find a gradually ascending series of forms as regards their differentiation from the oldest rocks to the present day our task would be quite simple. We have, however, no record of such a complete series. There is no doubt that in a general way we have the strongest possible evidence of evolution from palaeontology but many stages in the series are missing, and, what is more, we have not reached the beginning of the series yet. Among the plants known from the most ancient rocks a large number show a comparatively high grade of differentiation, far higher than that of the Liverworts, and we have no data as to what kind of plants which preceded them gave rise to them. As regards the fossil history of the Liverworts themselves I cannot do better than quote Dr. Scott. He says:—" The Palaeozoic records of this class of plants to which some botanists have assigned so important a place in the evolution of the Vegetable Kingdom are both scanty and doubtful. In the absence of any evidence as to reproductive organs or anatomical structure, it cannot be said that the presence either of the Hepaticae or of the true Mosses in the Palaeozoic rocks has yet been demonstrated. It is remarkable that no trace of either group has yet been found in the petrified carboniferous material, crowded as it is with all kinds of vegetative remains in which the most delicate tissues are often preserved. In fact the fossil records, as a whole, lend no support to the view, so often maintained on purely theoretical grounds, that the vascular plants owed their origin to a Bryophytic ancestry." (Progressus Rei Botanicae, 1907). He then cautions us not to lay too much stress on negative evidence but we shall see that a study of living forms also leads us to the same conclusion. Campbell says (Mosses and Ferns, 1905) that in the tertiary and later formations Liverworts are occasionally met with, but all the forms discovered are closely allied to existing species and throw no light on the origin of the Hepaticae. This disposes of the palaeontological evidence.

Evidence from development within certain limits is sometimes useful but great caution has to be used in drawing conclusions from developmental data alone. Like mature structures developmental stages are also subject to variation especially when such stages are not concealed within elaborate protecting structures as is the case in Liverworts. Some examples of evidence from this source would occur in the course of this address.

Thus our main evidence is derived from the comparative morphology of living plants. Here again it must be emphasised that generalisations from too small a number of forms are apt to be mistaken. This is one of the points which has been particularly brought home by the discovery of some Himalayan forms by the writer.

In considering a number of forms belonging to any particular group it is often possible to arrange them in a series from the simplest to the most complex, especially if only one or two characters are taken at a time. This is certainly the case with the Liverworts, particularly the Marchantiales. Supposing that a given series of this kind represents a natural group of plants we have to consider further whether it is really an ascending, as it is of course possible that the forms in question may really have arisen in a descending order, the simplest having arisen from the most complex by the process of reduction. A series of forms of gradually increasing complexity, therefore, may mean evolution in either direction though naturally it is simpler to suppose that evolution in such cases has proceeded in an upward direction unless there is definite evidence in favour of reduction. And this brings me to the question of intermediate forms which are either found in nature or sometimes put in hypothetically to complete a series. The argument from such forms cuts both ways. If we possessed all the intermediate forms necessary to bridge the gulf between the Liverworts and the Pteridophytes for example (and we do not possess these) it would not necessarily prove that the Liverworts were the plants which gave rise to the Pteridophytes or some similar higher forms. The converse may have been the case. That it has been so, can, I think, be shown clearly.

Bearing these considerations in mind let us see what connection can be traced between the Liverworts and the Algae. As has been stated above there is a big gap between the two and it has not been found possible to bridge it so far. A few forms among the Algae do show a certain amount of resemblance to the Liverworts but this is merely superficial and very incomplete even when we consider a single character. Three algal forms have usually been mentioned in this connection, *Coleochaete*, *Chara* and *Ectocarpus*. It is not maintained that any one of these is a starting point of the Liverworts. All that is meant is that they possess some characters which have a certain resemblance to similar characters in the Bryophytes though the plants are widely different in other respects.

Coleochaete resembles the simplest genus of the Marchantiales, *Riccia*, in having a small globular fruit—body resembling the capsule of the latter. It is well known, however, that the outer envelope in *Coleochaete* has an altogether different origin from that of the wall of the capsule of *Riccia* and belongs to a different generation. Then the structure of the thallus and of the sex organs in *Coleochaete* is very different from the structure of even a simple Liverwort. Campbell says, "It is pretty generally conceded that the origin of the whole archegoniate series is to be sought somewhere among the green Algae, and that on the whole *Coleochaete* is, perhaps, the form which is nearest to the simplest Muscineae." A little later he says, "At best, the connection between any known Alga and the Muscineae is a very remote one." As a matter of fact we can safely say that there is no connection at all.

In *Chara* the antheridia and oogonia have a certain resemblance to the antheridia and archegonia of the Bryophytes in so far that they are multicellular and have a similar shape but their mode of development and the structure of the thallus of *Chara* are entirely different from those met with in the Bryophytes, while anything like a sporogonium even in the most rudimentary condition is unknown in *Chara*.

The multilocular sporangium of *Ectocarpus* has served as an organ from which the antheridia and archegonia of the Bryophytes might be derived according to Davis. Apart from the purely hypothetical nature of the derivation there is nothing in this Alga which can show in any way that it has anything to do with the ancestry of the Liverworts.

Under the influence of a pet theory various attempts have been made to derive the Liverworts from the Algae by imagining hypothetical processes and even hypothetical forms, and the undisputable fact that no connection can be demonstrated and the obvious conclusion that therefore there is most probably no connection between the two have been ignored. Let us accept the fact that no connection has been demonstrated and also the conclusion that therefore there is no connection between the two. We shall see presently that this conclusion harmonises with that arrived at by a consideration of the comparative morphology of the Liverworts.

On the other hand if we consider the Liverworts in relation to the Pteridophytes we find several common features in the two groups. The thallus of some Liverworts is very much like the prothallus of some ferns and even other Pteridophytes; the general structure of the sex organs in certain types of the two groups is very similar; and the process of spore-formation is the same in both. I cannot believe as Tansley does (Lectures on the Evolution of the Filicinean Vascular System) that such characters have developed independently. They plainly show a common origin. The question only is whether we are to consider these forms in an upward line or a downward direction, not necessarily in a direct line with respect to any particular group, but only taking a broad point of view. The idea of an ascending series has been widely held and Professor Bower's theory of the strobilus has been a great instrument in the widespread belief in this view, while Professor Campbell is another eminent adherent of the same view. Professor Goebel on the other hand started the opposite idea of reduction in the Liverworts so that according to him the simplest forms have not given rise to the most complex but the case has been quite the contrary. Obviously if the lower forms in the Liverworts have been derived from the higher forms of that group, the further conclusion would be that the latter forms could have hardly given rise to the Pteridophytes—but on the contrary may have been derived from them. The writer has tried to establish certain principles of that reduction as well as the paths along which it has proceeded from the study of the Indian forms. It is curious to note that Professor Goebel was led to the idea of reduction in the Liverworts from his study of *Monoselenium tenerum*, a Liverwort originally described from India by Griffith some seventy years ago and which had been lost since then, until it was discovered accidentally by Goebel and investigated by him fully in 1910.

The principles mentioned above are best seen in the Marchantiales, perhaps, because these plants have been more thoroughly studied by the writer, but similar principles are also discernible in the Jungermanniales and the Anthocerotales.

I will take the genus Dumortiera first as it illustrates very clearly the process of reduction and some other phenomena. This genus comprises according to Stephani (Species hepaticarum) three species and a fourth was described by Campbell from Borneo a few months ago. (Annal of Botany, July 1918.) Of the first three, two, *D. hirsuta* and *D. trichocephala*, have been known from India and other parts of the world, but the third, *D. velutina*, has been said to be endemic only in Sumatra and Java. It has, however, been found by the writer to be extremely common in the Himalayas, from Mussoorie to Darjeeling, including some parts of the middle range of the main chain, e.g. the Chamba valley. It may incidentally be mentioned here that arguments from the distribution of some genera and species may not be very safe in the present state of knowledge. It should be mentioned however that the Himalayan specimens differ slightly from the type, especially in their densely setose male receptacles. Probably this plant has wrongly been considered to be *D. hirsuta* in the Himalayas. The most interesting point about this genus is the association with its aquatic habit of an entire absence of air-chambers in the mature thallus, the presence of such chambers being an important character of the Marchantiales. The air-chambers are, however, laid down at the growing point in two of the three Indian species, *D. tricocephala* and *D. velutina* but become disorganized later. It is quite clear that the process in this case is that of reduction.

The third species shows no trace of air-chambers even at the apex, the reduction having gone further. There can be no doubt, and the belief is generally accepted, that this loss of air-chambers is due to the aquatic habit, as under these conditions the air-chambers would be quite useless. The chambers at the apex, where present, contain projecting papillate cells which represent the filaments met with in the chambers of the higher forms of the group. In *D. velutina* these papillate cells are met with all over the thallus even in the mature state, and the boundaries of the chambers are indicated by reticulations on the dorsal surface. Similar reticulations, but more faint, are met with some distance behind the apex in *D. hirsuta* also, but the surface is otherwise perfectly smooth in this species and in *D. trichocephala.* As a matter of fact we can trace all the stages in the process of reduction in different genera according to their more or less aquatic habit. *Preissia commutata*, occurring on moist soil, shows the typical structure of the higher forms with air-chambers, pores and filaments. *Fegatella conica*, which grows in distinctly more moist places, has very short filaments in the greater part of the chambers, while immediately below the pores the terminal cell of the 2-celled filament is elongated and hyaline except at the base. In *Wiesnerella denudata*, another species common in the Himalayas and occurring either near or actually under water, the chambers contain only papillate cells, which is a step below *Fegatella.* The species of Dumortiera show the remaining stages, occurring as they usually do, actually under water. Some species of the genus have air-chambers containing papillate cells laid down at the apex; one has papillate cells on the dorsal surface even when mature; while some are perfectly smooth at maturity.

This interesting series showing the reduction of the air-chamber layer is however only a special case, as it is due to the presence of a special factor, the aquatic habit, and I would not have alluded to it if this were the only point illustrated by this genus. For, however clear this phenomena may be in this particular case it cannot be made the basis of a general conclusion regarding the whole group to which these genera belong. The other interesting point in this genus has been observed quite recently by the writer. Both in *D. hirsuta* where the air-chamber layer is confined to the apex and the older dorsal surface is quite smooth and in *D. trichocephala* in which there is absolutely no trace of air-chambers or papillate cells anywhere on the thallus, papillate cells are met with on the female receptacle. Here we have an illustration of the well-known principle seen in different groups of plants that the reproductive organs are more orthodox than the vegetative organs, i.e. retain traces of ancestral features longer than the latter. This principle acquires strong confirmation from the example quoted as the phenomenon occurs in an undoubtedly reduced form. This principle confirmed as it is in a member of the Liverworts will explain another structure also in them, the pores.

The pores in the higher forms of the Marchantiales are barrel-shaped both on the thallus and the receptacles. This is the case, for example, in the genera *Marchantia* and *Preissia.* In certain forms which are undoubtedly lower as judged by other characters, e.g. *Fegatella*, *Reboulia*, etc., the pores are barrel-shaped on the receptacles but those on the thallus are simple.

In some species of Plagiochasma examined by the writer it has been found that the pores on the female receptacle are barrel-shaped while those on the male receptacle are simple. Interpreted with the help of the principle enunciated above it means that the latter forms are reduced. We shall presently see that this conclusion is confirmed by other considerations also. In other forms like *Exormotheca* and *Stephensoniella* the pores are simple on the receptacle as well as the thallus. These forms would thus represent a still lower stage in the series. Lastly we come to the forms where there are no definite pores at all, as in the genus *Riccia*.

It is interesting to note that in some species the stomata are altogether lost, at least sometimes, while in others a tendency in this direction is distinctly visible. *Cyathodium tuberosum*, a species first described by the writer from Mussoorie, but since then sent to him from other parts of India also, often possesses no stomata in the sterile plants. In a plant recently sent to the writer by Professor Fyson from South India and which will have to be referred to a new genus, the thallus is very long and narrow and possesses no stomata in the greater part of its length and they only occur in its anterior part. In both these cases, however, air-spaces are present in the interior of the thallus. In the South-Indian plant the spaces in the posterior part are very small, suggesting that they are gradually being eliminated.

Another important point is the position of the receptacles. In the higher forms the male and female organs are found in groups on stalked receptacles which are usually terminal. In other forms they are dorsal. The stalk of the terminal receptacle is in direct continuation of the midrib and in the highest type, *Marchantia*, it possesses the typical pores and air-chambers on the dorsal side while it bears scales ventrally. It is, therefore, generally admitted that the stalk is a direct upward continuation of the thallus in these cases and the lobes of the receptacle represent the branches of the thallus. On account of the dorsal position of the stalk in some genera, like *Plagiochasma* and *Clevea*, Leitgeb considered that the stalk of the latter genera is a mere dorsal outgrowth and not homologous with the stalk of the higher forms. The case of *Preissia commutata* in which a terminal stalk becomes dorsal by the further growth of the thallus had been long known but on account of the groove on its anterior side it did not lead him to consider that the dorsal position of the stalk in the other genera might be secondary. Apart from the plausibility of this view on purely a priori grounds it has been shown by the writer that in *Plagiochasma articulatum* the stalk is terminal at first and becomes dorsal by the further growth of the thallus. The dorsal position is therefore secondary. The dorsal position of the stalk is arrived at similarly in the genus *Stephensoniella* described by the writer some years ago. This genus is extremely interesting in that it shows a close relation with the widespread genus *Exormotheca*. It agrees with the latter genus in having two involucres but it shows a simpler structure in all parts of its body; the air-chambers, pores, scales, stalk, receptacle, capsule-wall and elaters. There can hardly be any doubt that, like the dorsal position of the stalk, these different structures are derived from more complex ones and the plant is a direct descendant of *Exormotheca*. The short stalk and the very shallow groove are particularly interesting as they definitely show the transition from a stalked to a sessile receptacle along with the disappearance of the groove, while the dorsal position of the stalk again indicates the mode in which the dorsal position has been arrived at in *Plagiochasma* and others.

A further step in this downward direction can be seen in the genus *Corsinia* worked out by Leitgeb. Here the structure of the thallus is very nearly the same as in *Stephensoniella*, the male receptacle is quite like that of the latter, but the female receptacle is quite sessile, and the variously-lobed involucre which arises late is in general similar to that of the other genus. The sporogonium shows further reduction in that the cells of the capsule-wall and the sterile cells inside the capsule do not develop even the rudimentary thickening bands found in *Stephensoniella*. The main points in this evolutionary series are :—The gradual shifting of the terminal stalk to the dorsal position by the continued growth of the thallus; the gradual elimination of the stalk; the loss of the assimilating filaments in the air-chambers; the simplification of the stomata; the simplification of the capsule wall-cells and the elaters; and the decrease in the size of the seta. As a matter of fact it is an all-round reduction. In view of the transitional nature of the plant referred to the genus *Stephensoniella* between the so-called Marchantiaceae and the so-called Corsiniaceae it is not justifiable to keep the latter as a distinct family.

The last stage in this series would be the total suppression of the involucre and a further reduction of the sporogonium. This stage has been seen recently by the writer in the specimen already referred to above sent by Professor Fyson from South India. The material available was too little for much detailed investigation but enough has been seen to prove its great interest. In general habit the plant is very much like a *Ricciella*. The most interesting point about it is that it possesses a rudimentary foot of about four or five large spreading cells, while the absence of scales and the absence of stomata in the greater part of the thallus are other interesting points. In other respects it is quite like a typical *Ricciella*. The sporogonium projects conspicuously on the ventral surface. The sex organs are not in groups but scattered singly and in this respect it goes further than *Riccia natans*. This fact merely illustrates that reduction or differentiation does not affect all the organs equally.

Now I come to the two genera which are usually placed in the family Targionaceae. They differ considerably from each other. The study of the Indian species *Cyathodium tuberosum* by the writer has shown that the family is not so distinct from the so-called Marchantiaceae as has generally been supposed. The great interest of the study of *Cyathodium* lies in the fact that the genus is undoubtedly reduced and is accepted as such by all.

The most distinguishing character of this family is the terminal involucre situated at the apex of an ordinary vegetative shoot. We might say that the erect stalked receptacle of the *Marchantia*-type has become prostrate, or better still that the receptacle has become sessile and each involucre has grown out into a vegetative shoot bearing the archegonia at its apex. As in the series discussed above we had the displacement of the sex-organs to the dorsal surface by the continued growth of the thallus after the formation of the organs, similarly in the present series vegetative growth has taken place behind the sex organs with the result that the latter appear, not on an abbreviated receptacle, but at the end of a more or less elongated vegetative shoot. The transitional form between the stalked terminal receptacle of the *Exormotheca*-type and the *Targionia*-type can be clearly seen in the Himalayan genus *Aitchisoniella* discovered by the writer. In this plant the receptacle with one or two involucres is sessile and still abbreviated. Its elongation would lead to the *Targionia*-type. The sporogonium is of the same general structure as that of the two adjacent types.

The series is so complete that there can be no doubt as to the forms being really related. The only question that can arise is as to the direction in which evolution has proceeded, upwards or downwards. It is here that the reduced genus *Cyathodium* affords us great help as *Dumortiera* did in a similar matter. The male receptacle in this genus under ordinary conditions is a simple cushion-like structure situated on one side of a vegetative shoot or in between two such shoots. In better developed plants under favourable conditions the receptacle becomes large and of a composite type comparable with that of *Marchantia* but sessile and therefore resembling the female receptacle of *Aitchisoniella* but having more lobes. It shows that the original form from which Cyathodium has arisen came from a higher type like *Marchantia*.

The *Targionia*-type has still further led to lower types by the gradual shifting of the sex-organs to the dorsal surface and the elimination of the involucre, so that ultimately the same type is reached which was arrived at in other cases by a different route described above. This is a striking example of convergent evolution. The cause here again has been the predominance of vegetative growth. The intermediate stages in this series are shown by species of *Cyathodium* and *Riccia*. Most species of the former genus have their archegonia on the undersurface of the involucre as is the case in the higher types. One species, however, which is more reduced than the others in other respects also has the archegonia shifted actually to the upper surface by the continued growth of the apex which is situated far backwards in the other species by the well-known process met with in these Liverworts. (Lang, Annal of Botany, 1905.) The antheridia in Targionia are often found on the dorsal surface of a vegetative shoot. The archegonia are carried to the same position in a more pronounced manner in species of *Riccia*, which is a step further than is the case with the species of *Cyathodium* mentioned above. In the higher forms of this genus the remnant of the involucre is seen in the more or less broad median groove while in the lowest forms there is no trace of such a groove and these species are reduced in other respects as well. A very interesting example of this is furnished by the widespread Indian species *R. sanguinea* described by the writer. It shows no trace of a median groove, no scales, no tuberculate rhizoids and only a slightly differentiated epidermis. The absence of scales in the Indian species of *Riccia* is remarkable, the writer having come across no less than three such species, whereas Goebel mentions only *R. crystallina*, and even that as a doubtful case, in which scales are absent, in the whole of literature.

I am afraid I have devoted a long space to the Marchantiales though even now I have not touched all the important points. The phenomena of reduction, however, are so clear in this group that having considered them it is not necessary to follow them in detail in the other groups where moreover they have not been worked out in the same detail. The most conspicuous and general result of what has gone before is to show the great predominance of vegetative growth at the expense of reproductive shoots. It is also very easy to satisfy oneself of the great preponderance of vegetative growth and the very unimportant part played by reproduction by spores in these Liverworts. Most species of the Marchantiales can perennate in some way and some never produce any spores at least in certain localities Two species of *Marchantia* are quite common in Lahore but I have never seen any sporogonia on those plants during a number of years that they have been under observation. The transformation of the male shoots of *Marchantia palmata* into vegetative shoots and the formation of vegetative shoots from various parts of the stalk and female receptacle of the same species are phenomena of common occurrence. Similar shoots are very often met with arising from the male receptacle or from the base of the female receptacle in the genus *Dumortiera*. The power of revival after desiccation is an extremely common and well-known feature of the foliose Jungermanniales. The reproduction by spores, i.e. sexual reproduction ultimately, plays a very small part in the life history of the Liverworts, and that may possibly be one reason of the reduction which they progressively show.

I shall consider the Jungermanniales very briefly. They form, particularly the foliose forms, by far the largest number of Liverworts. They are, as a rule, met with in shady and moist places while the thallose forms occur, as a rule, in exposed places. It appears that the thallose forms have been derived from the foliose forms, as an adaptation to a drier habitat, by condensation. The transitional forms between the foliose and the thallose species are so common and so familiar that I need not mention them. I shall merely briefly refer to one point, i.e. whether the evolution has been from the thallose to the foliose forms or in the opposite direction.

The genus *Fossombronia* which is usually described as leafy, though the leaves are not very sharply marked off from the mere lobing of the thallus, is closely allied to the Himalayan genus *Sewardiella* described by the writer a few years ago. The latter genus is distinctly thallose and this is one of the main differences between the two genera. In *Fossombronia* the antheridia and archegonia are borne singly on the dorsal surface in association with some small leafy "bracts." In *Sewardiella* the sex-organs are aggregated and so are the bracts. In the female plant these bracts are quite free from each other in a very early stage of development but usually become coalesced later on and develop into a bell-shaped involucre by basal growth. This sequence of development, according to my interpretation, means that the plant has passed through a *Fossombronia*-stage and therefore originated from leafy ancestors. The intimate resemblance between the two genera indicates that it is most probably a case of direct descent. Investigations of other plants on similar lines would probably reveal more cases of this sort.

The Jungermanniales are as a rule prostrate or ascending and as a rule dorsiventral, but the curious family Celobryaceae contains erect forms. The plants are radial in *Calobryum*, but conflicting statements are met with regarding the second genus *Haplomitrium*. A detailed investigation of this family should also lead to interesting results but the required information is unfortunately not available at present.

If the view as to the origin of the thallose forms advanced by the writer is correct the further reduction of these to forms like *Sphaerocarpus* would naturally follow. There is absolutely no need of the assumption of a hypothetical form like *Sphaeroriccia* advanced by Lotsy.

The discussion of the origin of the dorsal position of the sex organs need not detain us any longer though it may be mentioned that the Calobryaceae are transitional in this respect. A gradual shifting of the archegonia is also seen in the other Anacrogynae.

The Anthocerotales can also be considered very briefly. There are only three or four genera in this group and both highly lobed and simple thallose forms are met with. Though at present there is no clear indication within the group as to which form, lobed or entire, is more ancient, in view of the relation of the group to the Pteridophytes to be mentioned presently, it seems highly probable that the lobed corresponding to leafy forms are more ancient and have given rise to the thallose forms. This would also be in accordance with what has been said about the Jungermanniales. There are however indications that the simpler thallose forms are derived from the more complex ones. The capsule in this group is an elongated structure which, in the higher forms like *Anthoceros*, projects far beyond a short involucre and opens by two valves. In the very simple genus *Notothylas* the capsule remains enclosed within the involucre and has never any occasion to open by valves, yet the position of the valves is clearly marked off even in this genus. This could hardly be interpreted in any other way but as a case of reduction. Similarly the sporogonium of *Anthoceros* has a well developed columella, but in *Notothylas* the columella may be well developed or absent even in the same species. This is, for example, the case in the Himalayan species *N. Levieri* examined by the writer, in addition to other species described by other investigators. The plants growing at Mussooree show no columella at all but those occurring at a lower level, at Dehra Dun or Allahabad, have a well-developed columella. This is also best interpreted as a process in reduction. It is probable, however, that the marginal position of the capsule in this genus has been retained from the ancestral form, while the dorsal position in *Anthoceros* and others is secondary as in the Marchantiales.

There is one Himalayan species, out of a few, of *Anthoceros*, to which I attach great importance from the point of view of the relationship of this group to the higher forms. This is *A. erectus* discovered by me some years ago. This species shows a gradual transition from an erect to a prostrate habit. Some plants are quite erect and possess a perfectly radial cup-shaped top on a cylindrical stalk, while others show an ascending or quite prostrate habit. In the latter case indications of the derivation of the prostrate habit from the erect radial structure are present at or near the base. This point should be remembered when a Liverwort thallus is compared with the prothallus of a Pteridophyte.

Having considered the general line of evolution in the various groups of the Liverworts let us see what relation they can have with the adjacent groups.

We have seen that no connection can be demonstrated between this group and the Algae, and the conclusion was that there is none. This conclusion becomes a certainty if we accept the view elaborated above that the simplest terms are the last terms in a descending series. If these simple forms are derived from the Algae it is strange that no trace of this relationship has been left anywhere. On the other hand we can say that there is no trace because there has never been any relationship.

On the other side we find several organs in common in the Liverworts and the Pteridophytes. The natural conclusion is that they have had some connection. Whether the Liverworts are derived from any of the modern groups of Pteridophytes through some unknown forms or from an extinct related group it is reasonable to suppose that, since evolution in this group has been towards simplification, the best developed gametophyte in the Pteridophytes would be somewhat like the ancestral form which gave rise to the Liverworts. Such a gametophyte is met with in some species of *Lycopodium*, e.g. *L. cernuum*. It is erect, radial, with a basal cylindrical portion and an upper leafy or lobe-bearing portion with a meristem all round. It is generally admitted that the genus *Anthoceros* approaches the higher types more nearly than any other Liverwort, on account of the highly differentiated capsule and the imbedded sex-organs. In this connection the radial and erect specimens of *Anthoceros erectus* referred to above acquire a peculiar significance. These specimens are very much like the prothallus of *Lycopodium cernuum* in general appearance except for the lobes of the latter

There must have been at least three different lines of simplification from such a type, represented by the Marchantiales, the Jungermanniales and the Anthocerotales. The first step would be a change from the erect and radial position to a prostrate and dorsiventral habit. Such a stage is very clearly shown by the prothallus of *Equisetum debile* described by the writer a few years ago. (Annals of Botany, 1913.) It shows a greater ressemblance with the types of the Marchantiales than the prothallus of any other Pteridophyte. It is a circular structure with a continuous marginal meristem, but it has no basal erect region at all, in which respect it differs from the prothallus of *Lycopodium cernuum*. Under certain conditions the prothallus of *Equisetum debile* develops only a single growing point like the prothalli of other species of this genus, and is then very much like an unbranched *Riccia*, only very small. The fully developed prothallus however may be as much as an inch across. The erect branched lobes of this prothallus correspond to the lobes of the prothallus of *Lycopo-*

dium cernuum, as well as to the erect assimilating filaments and probably also to the walls of the chambers in the Marchantiales on the one hand and the leaves of the Jungermanniales on the other. The development of chloroplasts in the scales of many species of the Marchantiales indicates that the scales correspond to the leaf-like lobes. Such a prothallus also would give rise to a fern prothallus by the loss of lobes and some other changes. The prothallus of *Eqisetum debile* is thus a highly synthetic structure showing relationships with several groups. It thus appears that the Liverworts are more closely related to the Equisetales than to any other group of the Pteridophytes. In this connection the reduction shown by the genus *Equisetum* in its leaves and its vascular system and the presence of spiral bands on the walls of its sporangia which are so common in the Liverwort capsule-walls are perhaps not without significance.

I have used the word reduction throughout to indicate the process of evolution in the Liverworts, but it should not be understood that every organ has been undergoing that process equally. There have no doubt been many modifications due to local causes. Then the very idea of predominant vegetative reproduction implies some modifications in the vegetative region. There can hardly be any doubt, for example, that leafy Liverworts are still undergoing modifications and producing new species by the variations in their leafy shoots.

This conception of the process of reduction in the Liverworts is also interesting in another way. It is well-known from palaeontological evidence that whole groups of plants like the Pteridosperms and the Sphenophyllales which flourished in very ancient times have left no representatives and widely-spread orders of former days have left only a genus or so as their modern representative. I mean, for example, *Equisetum* representing the huge ancient Calamarias and *Lycopodium* and *Selaginella* representing the ancient *Lepidodendrons* and *Sigillarias*. Let me quote Dr. Scott again. He says: " Groups of plants which now play an altogether subordinate part, or have disappeared altogether, were then (in Palaeozoic times) richly represented, and in many cases showed a far higher and more varied organization than is found among their nearest allies in later times. (Progressus Rei Botanicae, 1908.) Again Lady Isabel Browne says: " Many botanists regard the Equisetaceae as the direct descendants of the Calamariae. For as we pass upwards from the Palaeozoic tree-like *Calamites*, to the older of the Mesozoic *Equisitites*, which, though still very large, were smaller than *Calamites*, and to the more recent species of *Equisitites* and finally to the living *Equisetum* we trace a steady diminution in size." (New Phytologist, Vol. II.) To me it appears just what one might expect in many cases. During the evolution of the Vegetable Kingdom the forms which are superseded would perish but it would be strange if all such forms perish all of a sudden. It would be more likely that a number of them become gradually reduced before their entire disappearance. Many forms, therefore, which, like *Equisetum* or the Liverworts, are apparently perfectly sound and self-supporting to all intents and purposes are really on the down ward slope leading to extinction, though some like the Jungermanniales show a flicker before final disappearance. My firm belief is that reduction has played a far more important part than is generally believed in the history of the Vegetable Kingdom.

The Myxophyceae of Lahore.—*By* S. L. Ghose.

Practically no work has been done on the Indian blue-green algae, with the exception of a few records of some species by foreign writers.

The blue-green algae in Lahore are found in (1) drains and water-courses, (2) artificial tanks, (3) natural ponds and ditches, (4) lawns and pleasure grounds, after rain or watering, (5) tree trunks.

Habit and description of the following species are given:—(1) *Chroococcus turgidus*, Kuetz., (2) *Gloeocapsa polydermata*, Kuetz., (3) *Clathrocystis aeruginosa*, Henf., (4) *Oscillatoria princeps*, Vauch., (5) *Oscillatoria terebriformis*, Gom.. (6) *Oscillatoria tenuis*, Ag., (7)., *Arthrospira Jenneri*, Kuetz., (8) *Phormidium ladinianum*, Gom., (9) *Phormidium tenue*, Gom., (10) *Phormidium Hansgirgi*, Sohm., (11) *Phormidium moerlianum*, Grun., (12) *Lyngbya aestuarii*, Lieb., (13) *Microcoleus vaginatus*. Gom., (14) *Nostoc commune*, Vauch., (15) *Cylindrospermum majus*, Kuetz., (16) *Tolypothrix distorta*, Kuetz.. (17) *Tolypothrix byasoidea*, Kirch., (18) *Tolypothrix arenophila*, West, (19) *Rivularia bullata*, Berk.

Perennation. Terrestrial forms perennate by enclosing themselves in thick, firm sheaths. Resting spores have been observed in all stages of development in *Tolypothrix distoria*, Kuetz.

Conclusion. A more detailed research into the modes of perennation, multiplication and reproduction is still needed to complete the study of the blue-green algae of Lahore.

Variation in the flower of *Jasminum malabaricum*, Wight. —*By* H. H. Mann.

The flowers of the jasmines are extremely variable as to the number of corolla-lobes and calyx teeth which they contain. A recent stay in the neighbourhood of the Western Ghats in the latitude of Belgaum in April and May enabled a statistical study of these variations in *Jasminum malabaricum*, in an undoubtedly wild condition, to be made. Nearly 3,000 corollae were examined, and over 3,500 calyces.

The variation in the number of corolla lobes is between three and twelve, the most frequent number being eight. A smaller number than the mode is more likely than a larger number. The standard deviation is 0·9456, with a probable error of ± 0·0085, giving a coefficient of variability of 12·2. The variation in the number of calyx teeth is between four and eight, five and six being almost equally frequent. The standard deviation is 0·614, with a probable error of ± 0·00155, the variation being thus much less than with the corolla lobes.

The results indicate that the variation is chiefly a function of the individuality of the plant, and that the number of calyx teeth is not determined by the position on the plant, or by the earliness or lateness of the flowers.

The correlation between the number of corolla lobes and of calyx teeth is positive, but slight. The coefficient of correlation works out at

+0·1148 only, with a probable error of ±0·0071. That is to say there is a slight, but only a slight, tendency for the number of corolla lobes to increase as the number of calyx teeth increases, and *vice versa*.

On the ecological position of some types of Indian grassland.—*By* L. J. SEDGWICK.

Plant ecology is a study of great importance. Talbot's statement that we have in the Bombay Presidency no grassland formations is probably wrong. The climate of the Bombay Carnatic is a true grassland climate, and grassland formations prevail but are obscured by the density of the population. The continental authors would seem to include practically all tropical grasslands under savannah. But the Indian grasslands are too diverse to be included under one general ecological term. The word "savannah" is too loosely used. Warming uses it alike of one of his main classes and of certain formations within that class. These authors describe savannah in the narrow sense as an open formation of tall, stiff-leaved grasses growing in clumps with isolated tree-growth. The trees in the savannah are species which find their optima in grasslands and not as members of closed forests. Points suggested: (1) that the term savannah be limited to formations which comply with the above conditions, (2) that all tropical grasslands containing tree-growth is not therefore savannah, (3) that where the trees are species of monsoon forest we have not a single formation but a case of mixed vegetation, (4) that in the Bombay Carnatic there are three main types of grassland, two of which belong to Warming's "psilophytes," and the third is a transitional between this and "eremophytes," and (5) that the first two mix with monsoon forests and the third with thorn scrub. Points (2) and (3) are illustrated. There may be savannah trees in India, but the second condition—character of the grasses—must be satisfied. On these considerations there is probably no true savannah in the Carnatic. The three types of grassland are then described as,—(1) KURAN. a formation of tall, cuttable grasses with closely placed culms, (2) CHARAN, a dense mat of short-leaved perennials, and (3) BARREN UPLAND, a very open formation of slender grasses and sedges with a strong admixture of flowering herbs, all of which show adaptions to xerophtytism. Types (1) and (2) mix with monsoon forest. Type (3) mixes with thorn scrub. The latter is described. Its members are different from the members of the forest. The need of an ecological survey of India is urged.

The sub-aerial and fresh-water algae of the Punjab.—*By* M. C. SETHI.

1. Need of work on the algae of the Punjab, neglected, perhaps owing to their great similarity in all parts of the world. 2. Sub-serial forms. Several species collected by the author: *oscillatoria* and *pleuroccus* most common. 3. Fresh-water algae: several species were collected and studied from the oecological point of view 4. Periodicity in reproduction exhibited by the algae. The author's observations show that both external and internal conditions determine the formation of the sexual organs. 5. Some interesting new species collected by the author.

Note on the ecology of *Spinifex squarrosus*, Linn.—*By* P. F. FYSON *and* M. BALASUBRAMANIAM.

Spinifex squarrosus, Linn. is one of the chief dune-forming species of tropical shores, and is usually regarded as a halophyte, owing the peculiar characters of its serial parts to the "physiological dryness" caused by the presence of salt in the substratum water. An investigation of the roots shows that the piliferous layer immediately under and behind the root-cap is developed as a special mucilage-secreting layer, and that root-hairs are not developed till the part is much older, and are confined to parts near the surface of the sand. This peculiar mucilage-secreting layer has been recorded before from only one or two grasses which belong to the desert of North Africa, and which are in no way allied to *Spinifex*. The existence of the mucilage and the arrangement of the root-hairs points to the species being properly a xerophyte, and is relative to the question whether the strand-formation of the tropics should be regarded as halophytic at all.

An oecologically regressive vegetation on the Tinnevelly coast.—*By* P. F. Fyson.

An account is given of the vegetation of the promontory which juts out towards the north end of the island of Ceylon. The predominant tree is *Acacia planifrons*, W. & A., which is a feature of inland dry country. This occurs not only as forest trees with dense shade below, but in two other forms of dwarfing, with strongly epinastic shoots and branches.

Six distinct associations are noted, and it is shown that these represent a mixture of regressive inland forest-vegetation, with a progressive strand-formation, and this fits in with current belief that the sea has encroached on what was a complete connection between Ceylon and the mainland.

The occurrence is also noted of a pure association of the Naiadaceae plant, *Cymodocea australis*, Trim., on the submerged coral shelf which bounds the north side of the promontory, while two other species grow amongst the algae of the south side.

The flora of the Indian desert.—*By* E. Blatter.

The paper gives a general aspect of the flora of Jodhpur and Jaisalmer. It does not enter into ecological details, as these will be dealt with elsewhere. The orders represented are enumerated, together with the numbers of their respective genera and species. The prevalent orders are compared with those predominant in some other botanical regions. A study of the composition of the desert flora shows three well marked elements: A western (comprising African, Oriental, and Mediterranean species), an eastern (Indo-Malayan), and, finally, a more general element (incuding those species which are neither eastern nor western exclusively). Of endemic elements 17 new species are mentioned.

Morphology of some species of Pteries and Adiantum.—*By* M. Mitra.

1. The following ferns were examined:—

Adiantum Capillus-Veneris, A. Caudatum, A. Edgewarthi. A. lunulatum, Pteries longifolia, P. cretica, P. serrulata, P. ensiformis Var. Victoria and *P. quadriaurita.*

2. In order to obtain the skeleton of a fern it should be boiled in caustic potash dissolved in water.

3. In one of these was found a solenostele and in the rest simple forms of dictyostele.

4. In some the strands going to leave traces and side branches resemble each other in structure and origin. This with some other points support the theory that "frond is a modified shoot."

5. In one case perforation other than leaf-gaps appears.

6. The simplest type of leaf trace is one with two exarch protoxylem groups.

The rhizome and frond of *Gonioptreis Prolifera* (Rox).—*By* G. S. Cheema.

1. Introduction.
2. Rhizome:—external features, internal anatomy, effect of seasonal variations, difference in the sizes of gaps, variations induced artificially, extraction of philobaphene.
3. Root:—Important features.
4. Frond:—External characters, its habit, description of sorus, internal anatomy, nature of the bud, multiplication.

Notes on Vallisneria.—*By* L. A. Kenoyer.

Study of *Vallisneria spiralis*, collected in northern India has resulted in the recognition of at least four forms widely enough separated to be known as varieties. Among these the size difference between a dwarf shallow-water form and a large deep-water form is most striking. The floral characters are in the main closely similar in these Indian forms.

The comparison of the floral characters of the European form, as figured by Kerner, the American form, as described and figured by Wylie, and the Indian forms, reveal striking differences and make it highly probable that there are a number of species of Vallisneria.

A general consideration of some aspects of the fresh-water algal flora of Madras.—*By* M. O. Parthasarathy Ayyangar.

1. Though the fresh-water algae of the Indian region has been worked out by many algalogists, the Madras fresh-water algae have not been worked out at all.

2. The algal vegetation of Madras during the North-East Monsoon season is very interesting. The conditions of lighting, temperature, and the amount of gas dissolved in the water, approach somewhat to the conditions prevailing in temperate regions; and so the algal flora, too, assumes for the time being a temperate character. The blue-green algae which are generally predominant in the tropics are less dominant then. The green algae are more common as in the temperate regions.

3. Green algae can be seen growing everywhere in sub-aerial regions during this season, though at other times of the year the blue greens are the sole occupants of the situations. The following could be seen commonly occurring on the walls of houses giving them a bright green colouration as in the temperate regions:—

1. A species of *Protosiphon*.
2. A species of *Cylindrocystis*.
3. A species of *Pleurococcus*.

4. Trickling gelatinous masses of blue-green algae which are generally characteristic of the sub-aerial regions of the tropical uplands occur in similar situations in the low lands during the time.

5. A species of *Nitella* occurs on damp ground then. Members of the Volvocaceae also occur on wet sand around pools of rain water.

6. *Vaucheria Botrydium*, *Trentepholia* and *Ophiocytium* have not been met with by me in Madras. The place of *Vaucheria* is taken up by a species of *Rhizoclonium* which commonly occurs throughout the year in all moist shady sub-aerial situations.

7. The Cladophorales are represented in Madras by *Cladophora*, *Pithophora* and *Rhizoclonium*.

8. The members of the Volvocaceae occur very commonly in many pools during the monsoon season, for example, *Chlamydomonas Gonium*, *Eudorina*, *Pleuodorina* and *Volvox*.

9. Many temperate forms which are generally rare in the tropics occur commonly during this season, for example, *Ulothrix*, *Hormospora*,

Schizomeris, *Draparnaldia*, *Sirogonium*, and *Spirogyras* with replicate ends, etc., etc.

10. Desmids, both filamentous and solitary forms, are very common during the monsoon seasons, especially in rain water pools, ditches and paddy-fields.

11. Clathorocystis is a dominant plankton form in many open waters. This is well adapted to stand the strong tropical illumination. But during the monsoon season it dies out in large quantities owing to the weak solar illumination.

Section of Geology.

President—L. Leigh Fermor, *O.B.E., D.Sc., A.R.S.M., F.A.S.B., F.G.S.*

Presidential Address.

Some Problems of Ore Genesis in the Archaean of India.

(With Plate II.)

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I. Introduction.

At a scientific meeting the scope of a paper is usually circumscribed by the necessity of producing the facts concerning the views, hypotheses, or theories advanced, or is devoted to describing facts of Nature. But a presidential address may be regarded as freed to a certain extent from these necessary restrictions, affording the author a welcome opportunity of discussing one of the broader aspects of his science. Accordingly I must thank you for the incentive to reduce to order, and the privilege of placing before you, a summary of ideas resulting from considerable experience of the most ancient rocks of India.

A glance at the geological map of India shows at once that the Peninsula (as distinguished from the mountainous fringes constituting Baluchistan, the Himalayas and Burma) can be divided roughly into three geological terranes—the alluvium, the Deccan Trap, and the Archaean, with its associated Purana and Gondwana rocks. There is a comparative simplicity of composition and structure about the alluvium and the Deccan Trap, combined with a paucity of minerals of economic value, that has naturally caused the attention of Indian geologists to be directed in the past mainly to the study of the Archaean terrane with its associated patches of younger formations. At first attention was directed mainly to the Gondwana coalfields on account of their paramount importance to the industrial welfare of the country, the ancient Archaean rocks being disposed of in a very cursory manner. But during the last three decades an ever-increasing amount of attention has been given to the mapping and study of the vast areas occupied by the Archaean rocks of India, which are proving to be treasure houses not only of fascinating stories written in stone, often very damaged and difficult to decipher, concerning the early history of our globe, but also of vast stores of mineral wealth.

It is not surprising, therefore, that, during the short existence of this Congress, two addresses before this section have already been devoted to questions of Archaean geology. In 1915, at the second Congress, Dr. Smeeth read a very interesting paper entitled "The Geological History of Southern India[1]", which has been subsequently reprinted in a somewhat amplified form as an "Outline of the Geological History of Mysore[2]", a part of India almost entirely occupied by Archaean rocks. In 1917, Mr. Middlemiss, as President of this section at the fourth Congress, discoursed on "Complexities of Archaean Geology in India[3]". Both these geologists, in summarising the results of their prolonged researches into the damaged documents of Archaean times, concerned themselves with the broader and more theoretical aspects of Archaean geology and left untouched the philosophically narrower questions, so important nevertheless to man, concerning the vast stores of mineral wealth preserved in the Indian Archaean formations.

It seems to me fitting, therefore, that we should now devote some attention to this more practical aspect of Archaean geology, and I propose in this address to consider "Some problems of Ore Genesis in the Archaean of India."

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[1] *J. & P. A.S.B.*, XI, pp. 141–151 (1915).
[2] Bulletin, No. 6, Dept. of Mines and Geology, Mysore State (1916).
[3] *J. & P. A.S.B.*, XIII, pp. cxcv–cciv (1917).

II. The Origin and Relationships of the Archaean Formations of India.

Dr. Smeeth's views.

We must first refer briefly to the views of Dr. Smeeth and Mr. Middlemiss respectively. Broadly speaking, the geological map of Mysore shows elongated narrow strips of schistose rocks designated "Dharwars", separated by broad strips and areas of gneissose and granitic rocks of undoubted igneous origin. The Dharwar formation, as represented in Mysore, contains a variety of rocks, some of which, such as hornblende-schists, are of undoubted igneous origin; others, such as quartzites, limestones, mica-schists, phyllites, banded iron-ore rocks, and conglomerates, have long been considered by many geologists to be at least in part of sedimentary origin, their present physical and mineralogical peculiarities being attributed to metamorphic agencies, sometimes assisted by additions of igneous matter. As a result of the surveys of the Mysore Geological Department, Dr. Smeeth regards it as probable—although the evidence is not always conclusive—that the majority of these rocks are the products of igneous action, representing both lavas and pyroclastic deposits, since modified by metamorphism and chemical change. The chief exceptions according to Dr. Smeeth, are the conglomerates, which in every case where the evidence is clear, have proved in Mysore to be autoclastic or crush-conglomerates; and the banded iron-ore rocks, concerning which Dr. Smeeth writes (*l.c.*, p. 10):—

> "As to their sedimentary or aqueous character, definite proof is lacking, but the great consensus of opinion is in favour of such a view."

In addition to postulating an igneous origin for nearly all the rocks of the Dharwar system, Dr. Smeeth also regards this system as older that the associated "fundamental gneiss", which, according to the researches of the Mysore Geological Department, often shows intrusive relationships towards the Dharwar schists. The conglomerates sometimes found near the base of the Dharwars, which were once supposed to be true sedimentary conglomerates, indicating that the Dharwars are younger than the underlying fundamental gneisses, are now regarded by the Mysore Geological Department as of autoclastic origin.

Dr. Middlemiss' views.

Mr. Middlemiss (*l.c.*, p. cxcvi) finds the—

> "Revolution of thought, quietly and apparently unanimously undergone, by the members of the Mysore Geological Department, regarding the origin and relative age of these rocks and the series of mineral and physical transformations through which they have gone"

very unacceptable, at least in its entirety, and proceeds to cite cases of exposures in the Salem district where outliers of Dharwars rest on the hornblende-biotite gneiss in such a way that it seems necessary to accept the earlier view that the gneiss is older than the Dharwars. Where, however, an actual junction was found, fragments of Dharwar rocks were seen to be included in the Hosur gneiss. As Mr. Middlemiss observes (*l.c.*, p. cxcvii):—

> "With everything else in favour of the Dharwars being the younger formation, here is an appearance that I think the majority of observers would say showed that the intrusive gneiss was younger than the Dharwars!"

And, after summing up the evidence to the contrary, Mr. Middlemiss writes (*l.c.*, p. cxcviii):—

> "Thus the evidence is conflicting. Whilst general conclusions that have great weight are in favour of the younger age of the Dharwars, the particular section given above might be held to prove just the contrary.
>
> "Only, I think, by looking upon the Hosur gneiss as a rock that has passed through (it may be) several vicissitudes of solidification and plutonic re-melting without ever having developed much intrusive motion as regards the formations above, can the above conflicting testimony be harmonised."

With reference to the igneous origin that Dr. Smeeth wishes to ascribe to the Dharwar formation, Mr. Middlemiss observes (*l.c.*, p. cxcviii) that:—

> "No graphic representation of these extraordinary wholesale transformations of granites, quartz-porphyries and other igneous rock types, into schists, conglomerates, limestones and quartzites, has as yet appeared from the pencil of any of those responsible for the statements,"

and decides to suspend judgment until such data are forthcoming. He then proceeds to cite data collected by himself, by Mr. Burton and by me in various parts of India (particularly Idar State and the Central Provinces) indicative of an original sedimentary origin for the crystalline limestones and calc-gneisses, complicated in the latter case, according to Mr. Burton and myself, by *lit par lit* injection producing hybrid rocks.

Finally, Mr. Middlemiss turns the tables on Dr. Smeeth with the following closing passage (*l.c.*, p. ccii):—

> "Consequently, it seems to me that, in dealing with any rock that appears to be of doubtful igneous or magmatic origin, it is above all necessary in these days to ascertain in which direction the cycle of change is moving.

> To put the matter bluntly—an apparent ortho-gneiss with its contemporaneous veins may quite as well be an intensely metamorphosed sediment with pegmatities formed in it by 'selective solution' as it may be the extreme, foliated or otherwise modified, representative of a granitic, gabbroid or hybrid abyssal injection."

Districts visited.

Perhaps, I may be now permitted to express my own views on these points; for, without formulating, as far as possible, clear ideas as to the origin and relationships of the various members of the Archaean complex, it is impossible to deal satisfactorily with problems of ore genesis in the Archaean. Most of my field-work in India has been devoted to the study of ore-deposits located in Archaean formations or to the geological survey of areas in which Archaean formations predominate. In particular my work has lain in the Central Provinces and in Singhbhum, but I have also been fortunate in being able to visit at one time or another Ajmer-Merwara, Central India, Hazaribagh, Orissa, Sikkim, Ganjam, Vizagapatam, Bellary, the Sandur and Nilgiri Hills, Mysore State, Ratnagiri, and Portuguese India, and have thus been enabled to examine typical exposures of all the formations of Dharwarian aspect, viz. the Dharwars, Champaners, Chilpi Ghat series, the Aravallis, and the Dalings, to study the relationships to these formations to the Archaean gneisses and granites, and also to make the acquaintance of the Eastern Ghats type of Archaean rocks, characterised specially by the khondalite and charnockite series.

General contemporaneity of Dharwarian formations.

Based on this experience, I feel convinced that we may, in the first place, accept a general contemporaneity for the formations of Dharwarian aspect. This view cannot, of course, be supported on palæontological grounds, as no satisfactory evidence of the existence of life in Archaean times has yet been discovered in the Dharwar rocks; but it is justified on grounds of general degree of metamorphism, folding, and relationship to other Archaean formations. It is probable that no one area shows the complete sequence of Dharwar rocks, and deposition probably started and terminated at somewhat different points of time in different parts of India. There were also, doubtless, breaks in deposition giving rise to considerable unconformities within the Dharwars.

Igneous members of the Dharwars.

Secondly, as regards the origin of the rocks comprising the Dharwar formations, I prefer with Mr. Middlemiss to await the production of evidence by the Mysore Geological Department before accepting their wide-ranging conclusions as to the origin of the Dharwar schists. But I am probably prepared to go further than Mr. Middlemiss to meet Dr. Smeeth, for I have long ago recognised certain quartzites in Singhbhum as crushed vein-quartz and certain micaceous schists in Chhindwara as crushed gneisses, whilst I have been compelled to regard as autoclastic every Dharwarian conglomerate I have ever seen (not very numerous) except one in the Champaner rocks near Jhaban in the Panch Mahals.[1] Moreover, at one place in the Balaghat district Mr. Burton and I found it impossible to decide, even after chemical tests, whether certain microcline-quartzites were metamorphosed sediments or acid igneous rocks; and, of course, I accept as metamorphosed igneous rocks almost all epidioritic rocks and hornblende-schists.

Furthermore, work carried out in Singhbhum last winter renders it likely that the potstones and other magnesian schists in the Dharwars are merely metamorphosed ultra-basic rocks.

Sedimentary members of the Dharwars.

But, with these exceptions, the general trend of evidence appears to me to favour the view that the majority of the slates, phyllites, mica-schists, and quartzites of the Dharwars are metamorphosed sediments; and although I was once of the opinion that the highly crystalline limestones and calc-gneisses of the Central Provinces were chemically altered gneisses of unknown origin, both Mr. Burton and myself were eventually compelled by the evidence to accept them, in the main, as metamorphosed calcareous sediments, modified in part by contact-metamorphism and in part by *lit par lit* injection of acid igneous material.[2] In my brief visits to the Sandur hills, Mysore, and Goa, that is, to parts of India to which Dr. Smeeth's views more particularly apply, I saw phyllites and quartzites that appear to me to be indistinguishable from the presumed sedimentary Dharwars of the Central Provinces and Singhbhum.

Dharwars older than the "fundamental gneiss".

As regards the relationships of the Dharwars to the "fundamental gneisses", all the evidence I have seen forces me to the same conclusion as Dr. Smeeth, viz. that the Dharwars are the oldest rocks wherever they occur, and that the associated gneisses and gneissose granites are intrusive in their relationships. The junctions are obscured by debris, but, where visible, often show inclusions of the Dharwar rocks in the gneiss or granite (e g. in Singhbhum and at Jothvad in Narukot State) and sometimes veins of the granite in the Dharwars (e.g. at Jothvad). At other times the junction is a shear junction characterized by autoclastic rocks

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[1] W. T. Blanford, *Mem. G.S.I.*, VI, p. 41 (1869).
[2] *Rec. G.S.I.*, XLV, p. 102, (1915).

(e.g. in Rohra Nala in West Balaghat, Central Provinces, and near Srinagar, east of Ajmer). At still other times relatively unmetamorphosed Dharwars rest direct on granite, but without any intervening conglomerate (near Chaibassa). Finally, in many cases, both Dharwars and granitic rocks have been so severely metamorphosed that they dip isoclinally, and, as would be expected, it is no longer possible to unravel their relationships (e.g. in the Nagpur-Balaghat plain).

Pre-Dharwar gneisses re-melted.

But, on looking at the geological map of India, many geologists find it difficult to accept the idea that the vastly predominating gneisses and granites of India have intruded themselves into the much smaller shreds and areas of Dharwarian rocks. Accepting the view that a portion at least of the Dharwar schists was originally deposited as sediments, we must admit the previous existence of an earlier solid crust or land-surface, not only to provide by denudation the sedimentary material required for deposition, but also to provide a locus for sedimentation and for the extrusion of lava flows. Where is this early crust and the gneisses and granites (with perhaps still earlier sediments and lavas) which we may assume composed it? We must suppose that during the course of tectonic movements, the Dharwar sediments and lavas were buried and folded, and the lower portions carried, together with the underlying granites and gneisses, to a depth sufficient to ensure regional re-melting of the granites and gneisses with local absorption of a portion of the Dharwar sediments, this process being further complicated by the intrusion of fresh granite batholiths. To the stratigrapher the age of an igneous rock dates from the time it solidified, and, if the rock has been molten more than once, its age must date from the time of its latest solidification. Thus we see that the "fundamental gneisses", because they show intrusive relations towards the Dharwars, must be regarded as stratigraphically younger, but nevertheless they must, in part, represent the older crust—locally modified to a certain extent by assimilation, no doubt—on which, we may assume, the Dharwar sediments were deposited and the Dharwar lavas extravasated. The re-melting of the pre-Dharwar granitic crust, with fusion of the base of the Dharwars, will explain the general absence of the basal conglomerates in the Dharwar formation. This hypothesis does not inhibit the local preservation of the older gneiss and base of the Dharwars, but it is doubtful if such a case of preservation has yet been clearly identified. According, therefore, to the ideas now advanced we may regard the "fundamental gneiss" as composed in part of a pre-Dharwar gneissic crust re-melted and in part of post-Dharwar granites intruded from a lower depth.

Composite nature of the 'fundamental gneiss.'

Eastern Ghats facies of Archaean rocks.

Hitherto we have discussed the origin and relationships of what may be designated the normal type or facies of Archaean formations. But forming the Eastern Ghats of India we have another set of formations, which extends southwards into the hill masses of Southern India and Ceylon. This peculiar and abnormal set of formations may be designated the Eastern Ghats facies of the Archaean and comprises the charnockite series of Holland, the khandalite series of T. L. Walker, and a series of garnetiferous biotite-gneisses. Last winter I had occasion to tour Orissa in search of mica through country much of which is still geologically unsurveyed. As one result of this tour, I was led to discover the existence of what may prove to be a very important geological boundary or line. Its approximate position, as judged from my own observations and a study of the early geological reports concerning Orissa, is from the mouth of the Brahmini river on the coast, through the Talcher coalfield, across the Mahanadi river to the south of Sambalpur, as far as a point to the north of Borasambar. South of this line practically all the rocks are garnetiferous, consisting of garnetiferous granites and gneisses, of the garnetiferous schists and gneisses comprising the khondalite series and the hybrid Bezwada gneiss, and of basic members of the charnockite series, sometimes but not always garnetiferous. North of this line we have normal non-garnetiferous gneisses and granites and normal Dharwar sediments with basic epidioritic igneous rocks extending away into Chota Nagpur. It must be a matter for future research to demarcate accurately the position of the line (or zone) separating the normally garnetiferous formations from the normally non-garnetiferous formations, and to determine to what extent the difference between these two facies of Archaean formations is due to original differences of composition and to what extent to differences of dynamic or thermal history; but we may for convenience refer to the two main facies of Archaean formations in India as the Chota Nagpur facies or type and the Eastern Ghats facies or type respectively.

Chota Nagpur or normal facies of Archaean rocks.

In discussing now the ore-deposits of the Archaean in India, I propose to confine my attention to those found in the normal or Chota Nagpur type of Archaeans, except for a brief reference to the ore-deposits of the Eastern Ghats type at the end.

Classification of normal facies of Archaean rocks.

In view of the foregoing discussion on the origin and relationships of the members of the normal type of Archaeans in India, we may adopt the following general classification :—

(1) Oldest gneisses and granites—not yet certainly identified.

(2) Dharwar sediments and contemporaneous lavas.
(3) Oldest gneisses re-melted—now post-Dharwar and probably forming a considerable portion of the "fundamental gneiss."
(4) Post-Dharwar intrusives.
   (*a*) Peridotites and other ultra-basic rocks.
   (*b*) Granites and pegmatites.
   (*c*) Epidiorites (altered dolerites and gabbros).
   (*d*) Elaeolite-syenites.

These intrusives, especially the granites and related pegmatities, may belong to more than one period of eruption.[1]

III. ORE-DEPOSITION IN THE ARCHAEANS OF INDIA.

Ore-deposits the result of concentration processes of Nature.

Having formulated certain ideas as to the origin and relationships of these ancient rocks, we may now turn to the consideration of ore-deposition in the Archaeans of India. In an address to the Sibpur Mining Society some years ago, entitled "What is an Ore?" (*Jour.*, *Sibpur C.E. Col. Min. Soc.*, Vol. III, p. 39, 1908), I arrived at the following definition of an ore:—

> "A mineral substance containing an economically valuable metal in such quantity that, given a sufficiently large deposit of such mineral substance and a favourable situation of the deposit as regards transport and smelting centres, it will pay to work the mineral substance."

And, from the genetic point of view, I showed that we could regard an ore as:—

> "the result of the concentration by the processes of Nature of the originally very sparsely distributed metals, into mineral substances fulfilling the conditions as to composition just stated."

Distribution of ore-deposits in the Archaeans.

We will approach our problem from this latter point of view. Theoretically, any of the Archaean geological formations might contain concentrations of metalliferous minerals suitable for use as ores; but from the nature of things we must leave out of the question the hypothetical oldest gneisses. From theoretical considerations—which will appear later—it seems probable that the re-melted gneisses and granites of division (3) should also be poor in related ore-deposits. This leaves for consideration the Dharwar sediments and the post-Dharwar intrusives, and in practice we find that nearly all the important Archaean ore deposits of India occur in connection with these two sets of rocks. In the Dharwars we find metamorphosed iron-ore and manganese-ore deposits, representative in all probability of chemical sediments of contemporaneous deposition with the enclosing mechanical sediments, such as sands and clays. To such deposits we may apply the term "syngenetic". In addition, we find in the Dharwars many varieties of epigenetic deposits formed of minerals introduced during and since the folding and metamorphism of the Dharwars; in particular, ores of copper, gold, lead, and zinc, with rarer ores of iron, tungsten, and uranium. As will be shown below, the presence of these ores is in all probability due in many cases to granitic intrusions.

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[1] The Mysore Geological Department has recognised no less than three successive post-Dharwar granitic intrusives, known respectively as the Champion Gneiss, the Peninsular Gneiss, and the younger granites, which themselves may be of more than one age. The Peninsular Gneiss, which occupies by far the largest area, will probably be found to include the re-melted pre-Dharwar gneisses constituting my division (3).

Of the post-Dharwar intrusives the peridotites frequently carry chromite deposits. The granites, however, do not commonly carry valuable ore-deposits, having, as a rule, in course of solidification, added their metalliferous contents to the adjoining Dharwars. The pegmatites, of course, frequently carry valuable mica deposits and sometimes, in addition, pockets of ores of the rarer metals, such as uranium (pitchblende and samarskite) and tantalum (columbite and tantalite), as in Chota Nagpur and Nellore. The epidiorites are commonly devoid of valuable deposits, but may occasionally carry concentrations of titaniferous magnetite, as in Singhbhum; otherwise there is little evidence that the doleritic intrusions of various ages in India have contributed any appreciable quantities of metalliferous minerals to adjoining rocks. Similarly, no valuable ore deposits have been found in connection with the few known occurrences of elaeolite-syenites, although in Coimbatore associated felspar-rock carries corundum in large quantities.

Classification of Indian Archaean ore-deposits.

We may, therefore, suitably confine our attention to three groups of ore-deposits in the Archaean, viz. :—

(1) the syngenetic sedimentary deposits of the Dharwars, exemplified by iron and manganese deposits;
(2) the syngenetic igneous post-Dharwar deposits exemplified by chromite deposits in peridotite; and
(3) the epigenetic ore-deposits (mainly in the Dharwars) due to granitic intrusions, exemplified by lodes of copper, lead, zinc, gold, etc.

A. *Syngenetic sedimentary ore-deposits of the Dharwars.*

1. Iron-ores.

The banded rocks composed of magnetite, hematite, and quartz, or a fine-grained jasperoid or cherty form of silica, are noteworthy components of the Archaean terrane in many parts of the world, e.g. the Lake Superior region, Brazil, South Africa, India, and Western Australia; and, generally speaking, a satisfactory solution of the difficulties in connection with their origin in one part of the world should prove very useful in solving the problems connected with similar rocks in other parts. Although these silica-iron-ore rocks and associated iron-ore deposits occur in great abundance in various parts of India (e.g. Singhbhum, Mysore and Salem), nevertheless the Indian iron-ore deposits have not yet been opened up to any considerable extent, so that we lack the evidence of mining and boring operations that would enable us to draw conclusions as to both the origin and extent of these deposits, and we must at present accept the general results of the American geologists derived from the study of the Lake Superior occurrences. According to C. K. Leith in a paper summarising the results of the labours (extending over many years) of Von Hise, himself, and their co-workers[1], these rocks were originally deposited as a series of aqueous sediments, partly as cherty iron carbonates, partly as ferrous silicates, and partly as pyritic cherts, the source of the iron being regarded as the ancient basic volcanic rocks so abundant in the Archaean regions of North America. By subsequent chemical changes due to the influence of waters carrying oxygen and carbon dioxide, the iron as oxide and the silica have segregated from each other, with various results according to the structural conditions and subsequent tectonic history of each case, the resultant rocks being ferruginous cherts, jaspers, amphibole-magnetite-schists, and iron-ore bodies, all of which types of rock are found in India.

In Singhbhum and Orissa large bodies of hematite have been located recently along a high range extending for some 40 miles in a S.-S.-W. direction. Enormous quantities of ore exist, but in view of the genetic history of such ore-bodies referred to above, no predictions as to the continuity of these ore-bodies to the deep can safely be made in advance of the results of diamond drilling.

Surface modifications.

At the surface such ore-bodies, which are usually composed of hematite, are often found to be hydrated, as in Singhbhum and Goa, with production of a limonitic capping, immediately below which lies the compact hematite. Such development work as has yet been done in Singhbhum and Goa indicates, however, that below the compact hematite lies friable micaceous hematite and it is a matter of great practical interest to determine whether this tendency for the compact hematites to become friable with depth is the general rule.

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[1] *Trans. Amer. Inst. Min. Eng.*, Vol. XXXVI, pp. 101-153 (1905).

2. Manganese-ores.

Turning now to the sedimentary manganese-ores, we find a belt of country extending from Jhabua in Central India through the Nagpur-Balaghat portion of the Central Provinces as far as Gangpur State in Chota Nagpur, where, at intervals, valuable manganese-ore deposits occur in association with the manganese-garnet, spessartite, and the manganese-pyroxene, rhodonite, forming a series of rocks known as the *gondite series.*[1] These gonditic rocks and associated ore-deposits occur interbedded with a series of schists and phyllites, sometimes, as in Jhabua, of normal Dharwarian aspect, but sometimes, as in the Nagpur district, exceedingly crystalline. Not infrequently, these rocks are cut by pegmatitic and granitic intrusions, which sometimes carry fragments of manganese-ore (as at Gowari Warhona in the Chhindwara district),[2] or of gonditic rocks (as at Jothvad in Narukot State),[3] but still more often contain crystals of manganese minerals,[4] e.g. braunite, blanfordite, and greenovite (manganiferous sphene) : such facts prove in the former case that crystalline manganese-ores existed as such at the time of intrusion of these pegmatites and granites, and in the latter that richly manganiferous material (either manganese-ore or gonditic rock) was locally available for assimilation by the acid magma, leading to the appearance in the solid products of these exceptional minerals. On these grounds we are safe in concluding that a portion at least of the frequently highly crystalline gonditic ores are of pre-pegmatitic age, and on grounds of chemical composition and stratigraphical relationships, we are further justified in regarding them as representing original chemical sediments deposited sometimes in comparative purity and sometimes in admixture with, or interbanded with, mechanical sediments such as sand or clay. The purer ores (deposited probably as carbonate or hydrated oxide) on suffering subsequent metamorphism, yielded the crystalline braunitic ores (usually also carrying psilomelane), whilst the less pure ores yielded the mixtures of braunite, spessartite, rhodonite, and quartz, sometimes with other minerals, constituting the rocks of the gondite series. To what extent the banding of the gonditic rocks is a function of an original layered mode of deposition and to what extent it is the result of segregative changes during metamorphism, as is assumed for the Lake Superior iron-ore formations, it is impossible now to say.

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[1] *Memoirs, Geol. Surv. Ind.*, Vol. XXXVII, p. 306 (1909).
[2] *Rec., G.S.I.*, XLI, p. 5 (1911).
[3] *Mem., G.S.I.*, XXXVII, p. 646.
[4] *L.c.*, p. 336.

Mention has been made of the action of waters carrying oxygen and carbon dioxide in effecting a re-arrangement and concentration of iron in the Lake Superior iron-ore deposits. In the case of the Indian gonditic manganese deposits, it is probable, as shown above, that a considerable portion of the compact ore is of primary origin; but, in addition, there is clear evidence in some deposits that a portion of the ore has been formed by the alteration of the manganese-silicate minerals (spessartite and rhodonite) under the influence, it is presumed, of water carrying oxygen and carbon dioxide.

Surface modifications.

Mention has also been made of the surface hydration of Indian Dharwar hematite bodies with formation of limonitic cappings. Analogous cases of surface hydration of gonditic manganese-ores are rare,[1] but there is one very interesting case of surface modification worthy of special notice. The manganese-ore deposit at Sitapar[2] in the Chhindwara district was constituted at the surface by an unique assemblage of minerals, comprising braunite, with three minerals new to science,—*hollandite*, a complex manganate now found to be a crystalline form of psilomelane; *sitaparite*, a bronze-tinted manganese-ore; and *fermorite*,[3] a phospho-arsenate of calcium and strontium belonging to the apatite group of minerals. Owing to the bladed and coarsely crystalline grey metallic character of the hollandite and the bronze tint of the sitaparite, this ore, of which many thousands of tons have been exported, had a most striking appearance. This unique ore gave place in depth to the much finer grained normal braunite-psilomelane ore so typical of the gonditic ore-deposits of the Central Provinces; and there is no doubt that we have at Sitapar a striking example of surface modification of a manganese-ore deposit, characterised apparently by the formation of crystalline hollandite at the expense of the amorphous psilomelane of the normal ore, but even more strikingly by secondary enrichment in respect of arsenic, which now appears as a distinct material, arsenic being normally present in minute quantities in many of the gonditic ores of India.

One other aspect of the gonditic ore-deposits deserves mention, viz. the progressive increase in the phosphorus contents with increasing depth being experienced in practically all the manganese mines of the Central Provinces; the cause of this increase is at present unknown. If, as seems possible, the low phosphorus contents of the surface ores is due to surface leaching of the phosphorus compouud (? apatite), then the increase in phosphorus should cease once the ground water-level (past as well as present) has been reached.

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[1] Guguldoho, Nagpur district, is a good example. See *l.c.*, p. 949.
[2] *L.c.*, p. 785.
[3] G. H. F. Smith and G. T. Prior, *Mineralogical Magazine*, XVI, p. 84 (1911).

B. Syngenetic igneous ore-deposits.

Chromite Deposits.

Chromite deposits of Archaean age occur in Singhbhum, Salem, Mysore, and near Savantvadi, the other chief group of deposits (those of Baluchistan) occurring in saxonites of cretaceous age. Of these, I have been enabled personally to study the chromite deposits of Singhbhum and Baluchistan. The Singhbhum deposits are found in the Kolhan to the west of Chaibasa in a series of three ultra-basic intrusions in Dharwarian sediments (see Plate VI), consisting chiefly of slates with quartzose bands and rare bands of limestone. Although younger than the associated sediments, these ultra-basic intrusives have participated in the last set of earth movements and have suffered complex folding. The original rocks were chiefly enstatite-peridotite or saxonite, with subsidiary pyroxenite, lherzolite, and dunite; and moderately fresh examples of all except the dunite may still be collected. The dunites are completely serpentinised, whilst the saxonites and pyroxenites are in part serpentinised and in part converted to talc. The margins of these altered ultra-basic massifs are usually converted by shearing into talc-schist. The ore-bodies are usually in the form of bands, which, according to the evidence, are primary segregations drawn out. One case of a flow breccia, consisting of angular pieces of chromite in a matrix of serpentine, was also found.

Further to the east, in Dhalbhum, where the Dharwars have suffered much more intense metamorphism than near Chaibasa, talc-schists and potstones are of frequent occurrence in the Dharwars, and it seems likely that these magnesian schists represent the peridotite intrusions of the Kolhan modified by more intense metamorphism.

The possible chemical equations representing the formation of serpentine from olivine have been recently investigated by R. P. W. Graham,[1] in connection with the Quebec occurrences. Olivine, with the Mg : Fe ratio $= < 3 : 1$, may change to iron-bearing serpentine by simple hydration and oxidation without gain or loss of silica or magnesia, e.g. for Mg : Fe $= 1 : 1$;—

$$3Mg_2Fe_2Si_2O_8 + 6H_2O + O = 3H_4Mg_2FeSi_2O_9 + Fe_3O_4.$$

But with Mg : Fe $= > 3 : 1$, the conversion of olivine into serpentine must be accompanied either by addition of silica or by loss of magnesia. Taking the simplest cases, the equations would be—

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[1] *Econ. Geol.*, Vol. XII, pp. 162–170 (1907).

$$3Mg_2SiO_4 + SiO_2 + 4H_2O = 2H_4Mg_3Si_2O_9$$

and $$2Mg_2SiO_4 + CO_2 + 2H_2O = H_4Mg_3Si_2O_9 + MgCO_3.$$

In Singhbhum, the evidence indicates that the olivine is low in iron, although this has not been actually proved; so that we must postulate either siliceous or carbonated waters to effect the transformation of olivine to serpentine. As will be seen from the foregoing equations, the action of carbonated waters involves the formation of magnesium carbonate. A portion of this might be removed in solution, but some trace would probably remain in the form of magnesite. In the Singhbhum deposits I found no trace of this mineral, so that we have no evidence of the action of carbonated solutions. On the other hand, the rocks afford abundant evidence of the action of siliceous waters, for along a considerable portion of their margins, the peridotite *massifs* have been replaced by cherts, which, on account of their resistant nature, give rise to the highest peaks in the peridotite hills. In the cherts are preserved the structures of the original peridotites, but the only original mineral now left is chromite, so that we have a series of *chrome-cherts*. The extraordinarily resistant nature of chromite in the face of chemical changes is further exemplified by the discovery in one spot of a *chrome-marble* formed by the later replacement of the *chrome-chert* by calcium carbonate, the chromite grains still remaining unaltered.

Passing now to Southern India, we find the other method of serpentinisation exemplified. In the Chalk Hills of Salem, the altered chrome-bearing peridotites are traversed by networks of magnesite veins and dykes, affording abundant evidence of the method of alteration. Chromite has been found at many localities in Mysore, the principal of which are the Nuggihalli schist belt in the Hassan district, where the chromite is found in a talc-serpentine matrix derived from an altered tremolite-enstatite rock;[1] and the neighbourbood of Kadakola in the Mysore district, where bands and lenses of chromite have been found in serpentine formed by the alteration of dunite.[2] In the latter case magnesite has been found, suggesting, as at Salem, the action of carbonated waters. But in the Nuggihalli belt, both magnesite and chalcedony occur, so that here the method of serpentinisation must be regarded as undetermined at present.

Although it is now generally recognised that chromite deposits must be regarded as primary segregations from ultra-basic magmas, owing their present shape and distribution to factors pre-dating the serpentinisation of such rocks, yet Indian geological literature contains suggestions that serpentinisation is accompanied by the segregation of chromite, in particular with reference to the deposits of Salem and Baluchistan;[1] so that it is, perhaps, not out of place to record that the result of a careful study in the field of the evidence both in Singhbum and Baluchistan[2] is to show conclusively that in both areas the present form of the chromite deposits is the result of primary segregation, except where modified by movements due to mechanical causes. That this should be so seems reasonable in view of the great chemical stability of chromite as witnessed by the formation of the chrome-chert and chrome-marble referred to above, and as is taken advantage of in metallurgical practice when chromite is used as a neutral refractory material for separating the acid roof from the basic hearth in open-hearth steel-furnaces.

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[1] P. Sampat Iyengar: *Records, Mysore Geol. Dept.*, Vol. VII, pt. 2, pp. 38 and 39.

[2] W. F. Smeeth and P. Sampat Iyengar; *Mineral Resources of Mysore*, p. 111.

C. *Epigenetic ore-deposits due to granitic intrusions.*

Three cases of the probable introduction of valuable ore-deposits into rocks of Dharwar age by the intrusion of granitic magmas will be referred to:—

(1) The wolfram, apatite-magnetite, copper, uranium, argentiferous galena, and gold deposits of Singhbhum.
(2) The chalcopyrite-pyrrhotite and blende-galena lodes of Sikkim.
(3) The gold lodes of Kolar.

Ore deposition from granitic mother-liquors.

It is now a generally accepted idea that, when a granitic magma solidifies, all the surplus constituents not required in the formation of the granite collect into a more acid *mother-liquor*—constituents that were present only in minute quantities in the whole mass of the granitic magma being often thus concentrated into this residual fluid. The principal constituents of this residual magma are water, silica, alkalies and alumina, often with useful metals such as tin, tungsten, copper, lead, silver, gold and uranium, as well as such volatile non-metallic elements as fluorine, boron, sulphur, and less commonly chlorine; but the exact nature of these constituents in a given case will naturally depend upon the composition of the original magma.

It is difficult to formulate clear ideas as to the physical state of the constituents of this mother-liquor, but it seems safe to say that the more volatile constituents will not be truly liquid as long as the temperature is above the critical point for water. Moreover, as long as the temperature is at all high, there will be a tendency for a portion of the less volatile elements, such as silicon, aluminium, etc., to be kept in the vaporous condition by the help of fluorine, chlorine, boron, etc., which constituents are usually known as *mineralising agents.*

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[1] C. S. Middlemiss: *Records, Geol. Surv. Ind.*, XXIX, p. 33 (1896); G. H. Tipper: *Zhob District Gazetteer*, I, p. 187, (1907).

[2] *Rec., G.S.I.*, XLVIII, p. 12 (1917).

In many cases, this mother-liquor is able to deposit a portion of its burden in fissures in the granite itself, especially during the later stages of solidification, but it is largely injected into fissures in the surrounding rocks in a condition generally referred to as that of *aqueo-igneous fusion*—a phrase that masks our ignorance as to the exact physical conditions. The conditions of temperature and pressure decrease continuously from the granite towards the surface, so that in a continuous fissure there would be a gradual change, with distance from the granite, in the nature of the substances deposited.

Sequence of deposition in an ideal case.

In a complete case mica-bearing pegmatites will be deposited in and next to the granite, often carrying also such minerals as tourmaline and beryl, and more rarely pitchblende, samarskite, columbite, and other rare-earth minerals. The pegmatites pass upwards into aggregates of minerals formed under pneumatolytic conditions, i.e. conditions in which the temperature was above the critical temperature for water—cassiterite, topaz, and tourmaline, being specially characteristic of this zone. Above the cassiterite zone should come wolfram, which as these two minerals are sometimes intermingled, is also probably of pneumatolytic origin. Above this should come a zone of hydrothermal deposition characterised by sulphide minerals such as those of copper, iron, lead and zinc, with gold and silver, of which the copper and iron sulphides tend to be deposited nearest to the granite. Higher up still we may find barren quartz veins representing the surplus silica, and these may be succeeded by hot springs representing the final surplus of water.

This is, of course, the simple and ideal case pieced together from the evidence of many localities in different parts of the world. In practice, in any given case, some of the zones of deposition may be missing; in addition, as the general temperature decreases, each zone may recede towards the granite, so that, e.g., minerals characteristic of the hydro-thermal zone may be superposed on those of the pneumatolytic zone of a somewhat earlier period of deposition.

In the following study of ore deposition in Singhbhum, Sikkim, and Mysore, we shall in each case find it reasonable to attribute to intrusions of acid igneous magmas the introduction of valuable minerals into rocks of Dharwar type. It may well be asked how is it that, considering the vast area or Peninsular India occupied by Archaean granitic gneisses and granites, epigenetic metalliferous deposits are so scarce? The answer to this question may be of great interest. In the first place, the vast areas of gneiss and granite represent in many cases merely the deep-seated portions of batholiths, the upper parts of which, with their metalliferous contact zones, which may have been either in Dharwar schists or in pre-existing gneisses, have long been denuded away. In the second place, it does not follow that all granitic magmas in their original condition were sufficiently rich in metalliferous constituents to yield ore-deposits, or, if so, that the conditions of solidification were favourable to the concentration of these constituents into ore bodies. But there may be another very good reason. We have already suggested that a considerable portion of the "fundamental gneiss" of India may be an older pre-Dharwar gneiss re-melted so as to appear now as a later intrusion. This old gneiss doubtless lost its mother-liquor, metalliferous contents, and mineralising agents, at the time of its original solidification. Re-fusion could not put these constituents back into the magma, except in so far as portions of a metalliferous aureole may have been also re-melted and assimilated in the granitic magma. This consideration means that, whereas we may expect a primary or virgin granitic magma to produce mineralisation of the rocks into which it is injected, we can hardly expect this of a secondary or re-melted granite.

Comparative scarcity of Archaean epigenetic ore-deposits in India.

Primary and secondary granites.

In addition to the epigenetic ore-deposits discussed in this section of my paper, there is a considerable number of small deposits of copper, lead, gold, etc., scattered over the Archaean terrane of India. It will be of interest in the future to determine the extent to which these deposits are to be regarded as due to post-Dharwar granitic intrusions and the extent to which they are in any way related to the suggested re-melted gneisses. Some of these deposits, particularly some of the small lead and copper deposits found in Hazaribagh, the Sonthal Parganas, and other parts of Chota Nagpur, are associated with silicate minerals such as garnet, diopside and tremolite, in such a way as to suggest that they may be contact-metamorphic deposits; if so, future research may point to the necessity of establishing a sub-group of the epigenetic deposits to include such occurrences.

Contact-metamorphic deposits.

Let us now discuss in turn each of the three areas Singhbhum, Sikkim, and Kolar.

1. Singhbhum.

(See Plate II.)

Copper-ores.

In Singhbhum a great batholith of granite (the Singhbhum granite) has lifted up the Dharwar rocks—chiefly phyllites and quartzites—which, consequently, as a rule, dip off the granite. Approximately parallel to the N.E. and N. margins of this granite, but contained within the Dharwars, is a belt of old copper workings, which is continued to the west by further old workings associated with two other acid intrusive massifs, viz. the Akarsani granophyre (possibly a hypabyssal form of the Singhbhum granite) and the Chakardharpur gneiss (a composite gneiss constituted partly of older rocks and partly of intrusives related to the Singhbhum granite and the Akarsani granophyre).[1] Several miles to the north is a large intrusion of dolerite known as the Dalma Trap and now altered to epidiorite. This trap also exhibits parallelism to the copper belt. But, when we notice that, except at the S.E. end, the copper deposits are all within four miles, frequently one or two miles or less, of the granites, we appear to be on safe ground in attributing the appearance of the copper in the Dharwars to the granite and not to the trap. In the S.E. where the granite ceases, the trap also comes to an end, but it seems probable that the granite continues as a tongue beneath the Dharwars in this direction.

Magnetite-apatite-rocks.

At intervals along the copper belt we find, intercalated in the Dharwars, small lenticular bodies of magnetite-apatite-rock, which are specially abundant in Dhalbhum (at Patharghara, Badia, Sunrgi, etc.) and are so closely associated with the copper deposits that they often crop out in the sides of old workings. At one locality (Sunrgi) the magnetite-apatite-rocks are stained with green and yellow incrustations of torbernite and autunite.

Uranium.

Pegmatite.

On the dumps of the old workings are often found small fragments of pegmatitic and granitic rocks indicating the existence of apophyses of these rocks in the Dharwar sediments.

Wolfram.

At Kalimati, some five miles north of the granite, there is an isolated wolfram-quartz deposit, and, at a much greater distance, moderately close to the Dalma Trap, lies the argentiferous galena deposit of Dhadka in Manbhum.

Argentiferous galena.

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[1] See map accompanying V. Ball's "Geology of the Districts of Manbhum and Singhbhum." *Memoirs, Geol. Surv. Ind.*, Vol. XVIII (1880).

Gold.

In addition, various occurrences of auriferous quartz lodes have been located, of which perhaps the most noteworthy is that of Kundrakocha close to the southern boundary of the granite.

Perhaps, I should mention that the tendency of all these mineral deposits is to occur in impregnated zones, lenticular veins and lenses parallel to the lamination of the enclosing phyllites and schists.[1]

Mineralisation probably due to granite rather than Dalma Trap.

In considering the distribution of these various ore-deposits as a possible index to their source, we are confronted with the presence of two sets of igneous intrusives, viz. the acid granites and granophyres, and the basic epidiorites constituting the Dalma Trap and the numerous dykes traversing both the Singhbhum granite and the Dharwar schists. At first sight it might seem that either of these sets of intrusives might equally well be regarded as the source of the mineral-bearing solutions. But, in view of our knowledge of such rocks elsewhere, we are compelled to attribute the pegmatites and the wolfram-quartz deposit to the acid magma, and the close association of the copper deposits and the magnetite-apatite-rocks with the Dharwar-granite boundary leaves little doubt that these minerals, as well as the associated uranium, must also have emanated from the granite. This leaves only the argentiferous lead deposits and the gold deposits. As will be seen from the account given above of the general order of deposition in a typical case, we might expect lead, gold and silver to be deposited at a greater distance from the source than, say, the copper-ores, and consequently, nearer to the Dalma Trap, so that the proximity of the argentiferous galena of Dhadka to the Dalma Trap may have no genetic significance.

The auriferous veins of Singhbhum are widely distributed and seem to favour by their proximity neither the acid nor the basic intrusions; but, in view of the fact that galena is sometimes associated with the gold, and the fact that the evidence in favour of the Singhbhum granite as an agent in promoting the general mineralisation is strong, whilst that in favour of the Dalma Trap in this respect is *nil*, I am inclined to regard the barren quartz veins of Singhbhum and the gold and argentiferous galena deposits as representatives of the latest phase of ore deposition in this district. Maclaren, in connecting the deposition of gold in Chota Nagpur with the basic intrusions, writes:[2]

> "All things considered, we are brought to the conclusion that the deposition of the gold in the veins resulted from

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[1] *Rec., G.S.I.*, XXXVIII, p. 36 (1909); and XLII, p. 75 (1912).
[2] *Records, Geol. Surv. Ind.*, XXXI, p. 81 (1904).

> the intrusion of this diabasic rock, but as to whether the auriferous solutions were brought from below with the igneous magma, or as to whether the magma simply furnished the solvents that, on percolation through the adjacent, presumably, sedimentary rocks, caught up their already contained gold, we have at present no clue."

Although as shown above, I am inclined to look for the ultimate source of the gold in the acid intrusives, it is not in the least impossible that the later basic intrusions may have led to some subsequent re-arrangement, with possible further concentration, in some cases, of mineral contents already contributed to the Dharwars by the granites.

Order of deposition.

Accepting as a working hypothesis the view that most of the epigenetic ore-deposits in the Dharwars of Singhbhum owe their origin to the intrusion of the granites, we may briefly notice the evidence they afford as to their order of deposition. On the basis of relative proximity to the granite, the pegmatites, magnetite-apatite-rocks, copper deposits and uranium minerals pre-date the gold and argentiferous galena, which is as we should expect. Of the pegmatites and deposits near the Dharwar-granite boundary we may on a priori reasoning assign an earlier age to the pegmatites than to the other deposits. Where the magnetite-apatite-rocks and copper deposits occur together, the chalcopyrite is found to replace metasomatically the magnetite and the apatite. In the magnetite-apatite lenses themselves the magnetite is later than the apatite. The uranium "micas" that occur on the magnetite apatite rocks are, of course, surface secondary products, formed at the expense of some primary uranium mineral not yet discovered. This leaves only the Kalimati wolfram-quartz deposit. On account of its greater distance from the Singhbhum granite than the copper belt, we should attribute a slightly later age to the wolfram. This would be a reversal of what is customary in other countries, e.g. Cornwall, and the position of the wolfram deposit may be explained in two ways: either the wolfram represents a very early period of deposition, when the minerals characteristic of a given zone were deposited further from the source than at a later cooler period, or it may be due to an underground extension of the dyke-like apophysis of the Akarsani granophyre, which has been traced for some miles to the east. The rough order of deposition deduced for Singhbhum is thus as follows :—

Oldest.

Pegmatites	Pegmatitic zone.
[Wolfram-quartz veins] [1]	Pneumatolytic zone.
Magnetite-apatite rocks	
[Unknown uranium mineral] [1]	
Chalcopyrite	Hydrothermal zone.
Argentiferous galena	
Gold	
Barren vein quartz	

There will, of course, prove to be local exceptions to this order.

2. Sikkim.

In Sikkim, numerous chalcopyrite-pyrrhotite lodes and argentiferous blende-galena lodes have been discovered interbedded with the slates, phyllites and schists of the Daling series, regarded as equivalent to the Dharwars of the Peninsula.[2] The area occupied by the Daling rocks is not large, and is surrounded by gneisses, regarded as of younger age. In addition, there is a granitic intrusion in the midst of the Dalings. Basic igneous intrusions are rare. Copper deposits have been found in many parts of the Daling area, both close to, and far from, the gneiss boundary; but, in view of the small area of the Dalings, this is not surprising. The copper and other metalliferous deposits are clearly epigenetic with reference to the Dalings, and, in view of the rarity of basic igneous rocks, we are on fairly safe ground in attributing the minerals to the acid intrusives. Although the conditions are comparable with those of Singhbhum, there are also marked differences. Blende and galena are frequently found in the chalcopyrite-pyrrhotite lodes, showing that the sulphide minerals have not been so effectively separated as the chalcopyrite and galena of Singhbhum. Both in Singhbhum and Sikkim, the chalcopyrite tends to be slightly auriferous, but only in Singhbhum have separate gold lodes been found. On the other hand, the copper of Sikkim is occasionally associated with bismuth, antimony, tellurium and cobalt; and tetradymite (Bi_2Te_3) and linnaeite (Co_3S_4) have been identified.

3. Kolar.

The gold of Kolar occurs in veins of blue or grey quartz enclosed in the hornblende-schists of the Lower Dharwars of the Mysore Geological Department, and in intrusive relationship to these hornblende-schists is a gneiss known as the Champion gneiss by the same Department. In addition to gold, the quartz contains very small amounts of pyrite, pyrrhotite, arsenopyrite, blende, galena and chalcopyrite. Maclaren in his comprehensive work on gold, divides the pre-Cambrian gold deposits of India into two groups, viz. those of Archaean age associated with blue or grey quartz in hornblende-schists of Dharwar age as in Kolar and Hutti, and those of Cuddapah age associated with white quartz found in the Dharwar phyllites and chlorite-schists of Dharwar and Singhbhum. With reference to the latter, Maclaren writes [1] :—

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[1] Exact position of minerals in brackets uncertain.
[2] *Rec.*, *G.S.I.*, XLII, p. 74 (1912).

> "In all cases it would appear that the auriferous solutions have been set in circulation by diabasic flows and intrusions, but not even a guess may be made as to whether the gold was brought to its present position by the uprising diabasic magma or whether the diabasic and dioritic intrusions found the schists already auriferous and served only as carriers of heat and of solvent vapours."

For Singhbhum we have above adopted the latter alternative, if the intervention of these basic magmas is to be admitted at all.

In the case of the older group of gold deposits, such as those of Kolar, belonging to his Erythraean province, Maclaren finds the evidence too scanty to permit of any generalisation as to the source of the gold, and is content to notice the association of these gold veins with hornblende-schists. W. F. Smeeth and P. Sampat Iyengar [2] divide the Dharwars of Mysore into a lower division consisting of dark hornblende schists and amphibolites and an upper division consisting of greenstones, chlorite-schists, calc-chlorite-schists and talcose schists. They write (*l.c.*, pp. 8 and 9) :—

> "Maclaren has noted the above distinction between the auriferous veins of the chloritic and hornblendic rocks and suggests that those of the hornblendic series are much older than those of the chloritic series which latter he conceives to be associated with the great igneous activity represented by the numerous dolerite dykes which traverse the schists and gneisses and therefore of post-Archaean age. We are unable to agree with this latter suggestion. It may be true that the dark veins in the hornblendic rocks are older and more crushed than the white veins of the chloritic series, but even this is by no means certain. The degree of crushing is locally very variable in both cases, and some of the white veins show considerable signs of crushing and movement, and appear to be older than many of the barren veins of quartz and pegmatite which occur in the schists

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[1] Gold: Its Geological Occurrences and Geographical Distribution, p. 54 (1908).

[2] (Mineral Resources of Mysore, pp. 7 and 8 (1916).

> and gneisses and which are intruded by the dolerite dykes. The latter show no signs of crushing or movement whatever. It must be remembered that Maclaren regarded the schists as laid down on, and later than, the fundamental gneiss and was therefore debarred from regarding the latter as a source of the quartz and gold. We take the opposite view as explained in the following section."

According to these authors (*l.c.*, p. 10)—

> "The auriferous veins of the Kolar field are intrusive into the schists and produce contact-metamorphic effects which are strikingly similar to those produced by the gneisses, granites and pegmatites and strongly support the view that the auriferous veins are igneous in origin and to be regarded as one of the end-products of a granite intrusion. Tongues of micro-granite which are regarded as belonging to the Champion gneiss come into the Mysore mine in close proximity to the Champion lode and the quartz of the latter has been observed to penetrate these tongues."
>
> "On the other hand, the great mass of the Peninsular gneiss cuts off both the auriferous schists and the Champion gneiss while the pegmatite veins and cross-courses which cut the Champion lode are probably products of the intrusion of the Peninsular gneiss. The auriferous veins of Kolar appear therefore to be subsequent to the Champion gneiss and prior to the Peninsular gneiss (or some of it) and in seeking a granitic origin for the gold-bearing veins the Champion gneiss appears to offer a handy and suitable source."

With reference to the white veins of the chloritic series, these authors point to the possibility of this also being due to intrusives belonging to the Champion gneiss, but regard the evidence as inconclusive. And should this auriferous activity not prove to be attributable to the Champion gneiss, they write (*l.c.*, p. 11)—

> "There is, however, ample opportunity for the occurrence of later quartz veins of granitic origin in connection with the intrusions of the various components of the later Peninsular gneiss, to say nothing of possible later or earlier acid relatives of the ultra-basic or other intrusives of the Archaean period."

As there is no evidence in India of any genetic connection between either hornblende-schists or epidioritic rocks and the introduction of gold into the Dharwar schists, whilst there appears to be fairly good evidence at Kolar of the connection of the gold with the Champion gneiss, I am inclined to follow Smeeth and P. Sampat Iyengar in attributing the auriferous deposits in the Dharwars of India to the activity of acid rather than of basic igneous rocks.

IV. SUMMARY.

We may now summarise briefly the views expressed in this address. Discussing the conflicting opinions of Dr. Smeeth and Mr. Middlemiss as to the origin and relationships of the Dharwars, we find it probable that the rocks constituting the Dharwar formation are in part of sedimentary and in part of igneous origin (extrusive lavas); most of the conglomerates are of autoclastic origin; and no undoubted case of the Dharwars resting with a basal sedimentary conglomerate on an older gneissic series has been found. The so-called "fundamental gneiss," on which the Dharwars often appear to rest, frequently shows intrusive relationships towards the Dharwars, and consists partly of primary post-Dharwar granites but is perhaps in part composed of pre-Dharwar granites or gneisses re-melted, so that they now present intrusive contacts towards the Dharwars, and must be treated from the stratigraphical point of view as post-Dharwar. In fact, as far as we know, the Dharwars must be regarded as the oldest known rocks in India.

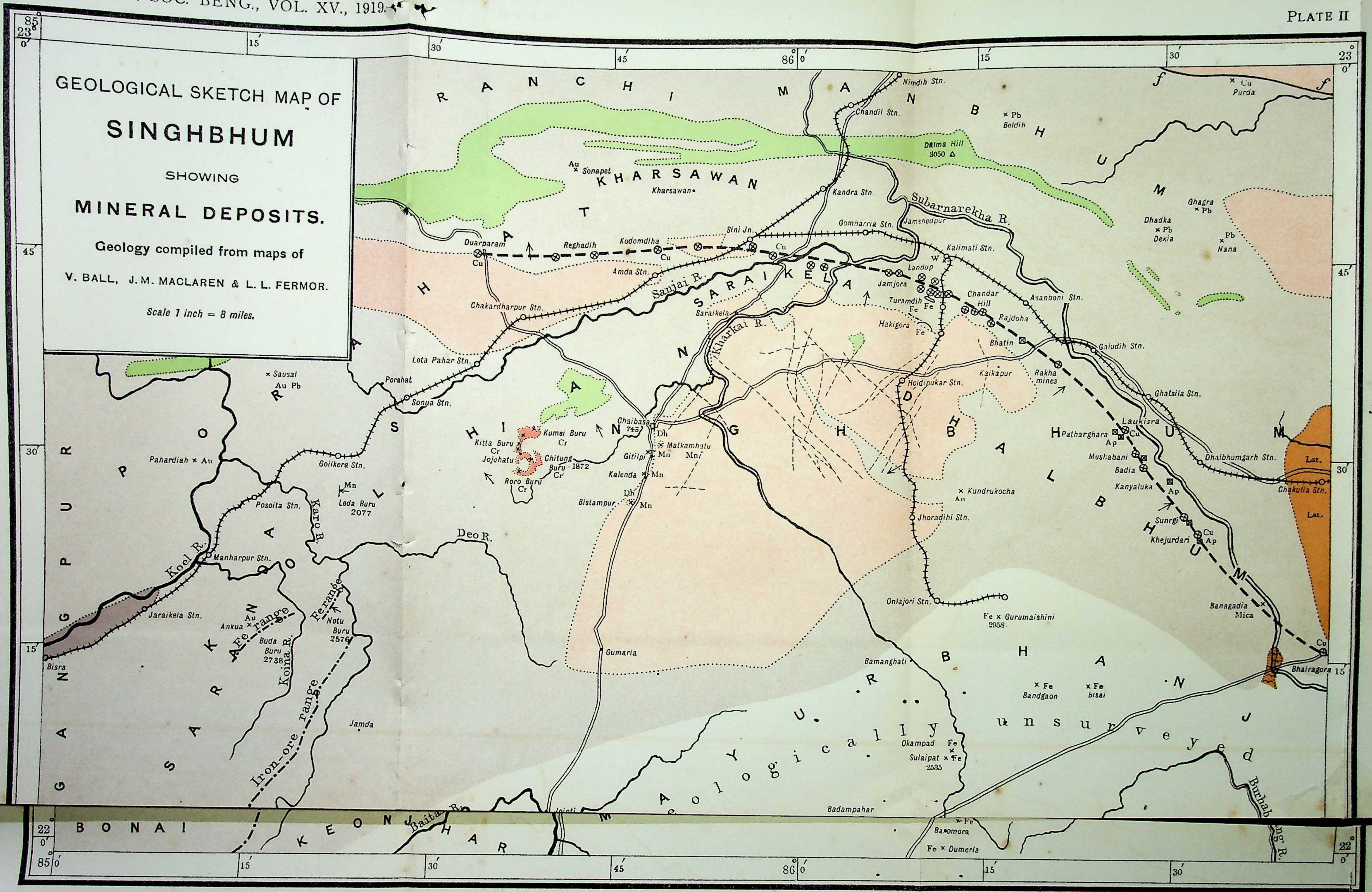
On this basis the Archaeans of India may be classified as follows:—

(1) the oldest gneisses—no known representatives;
(2) the Dharwars;
(3) the oldest gneisses re-melted and now post-Dharwar;
(4) post-Dharwar intrusives, comprising peridotites, granites, pegmatites, dolerites and gabbros (now epidiorite), and elaeolite-syenites.

This classification applies to what may be termed the normal or Chota Nagpur type of Archaeans. In addition, we have what may be termed the Eastern Ghats type characterised by khondalites, the charnockite series, and garnetiferous gneisses.

In discussing problems of ore genesis, I have confined my attention to the Chota Nagpur type of Archaeans, and have given brief accounts of the three chief groups of Indian Archaean ore-deposits, viz.:—

(1) metamorphosed syngenetic sedimentary ore-deposits represented (*a*) by the quartz-iron-ore rocks and associated iron-ore deposits of Singhbhum, Salem, Mysore, in part rearranged, and (*b*) by the gonditic manganese-ore deposits of the Central Provinces;
(2) syngenetic igneous ore-deposits represented by the chromite deposits of Singhbhum, Mysore and Salem;
(3) epigenetic veins and impregnations in the Dharwars which, for three different areas, viz. Singhbhum, (wolfram, apatite, magnetite, copper, argentiferous



GEOLOGICAL SKETCH MAP OF SINGHBHUM

SHOWING

MINERAL DEPOSITS.

Geology compiled from maps of

V. BALL, J. M. MACLAREN & L. L. FERMOR.

Scale 1 inch = 8 miles.

RANCHI
MANBHUM
KHARSAWAN
Kharsawan
Au × Sonapet
SARAIKELA
Saraikela
DHALBHUM
SINGHBHUM
KOLHAN
PORAHAT
GANGPUR
SARANDA
BONAI
KEONJHAR
MAYURBHANJ
Geologically unsurveyed
Nimdih Stn.
Chandil Stn.
× Pb Beldih
Dalma Hill 3050 △
Kandra Stn.
Subarnarekha R.
Gomharria Stn.
Jamshedpur
Sini Jn.
Kalimati Stn.
Landup
Jamjora
Turamdih Fe
Fe
Chandar Hill
Rajdoha
Hakigora Fe
Bhatin
Asanboni Stn.
Galudih Stn.
Kaikapur
Rakha mines
Haldipukar Stn.
Ghatsila Stn.
Laukisra
Patharghara Ap Cu
Mushabani
Badia
Kanyaluka Ap
Sunrgi
Khejurdari Cu Ap
Dhalbhumgarh Stn.
Chakulia Stn.
Lat.
Banagadia Mica
Bhairagora
× Kundrukocha Au
Jhoradihi Stn.
Onlajori Stn.
Fe × Gurumaishini 2958
Bamanghati
× Fe Bandgaon
× Fe bisai
Okampad Fe
Sulaipat × Fe 2535
Badampahar
× Fe Bamomora
Fe × Dumeria
Burhabalang R.
× Cu Purda
× Pb Ghagra
Dhadka × Pb Dexia
× Pb Nana
Duarparam Cu
Reghadih
Kodomdiha Cu
Amda Stn.
Cu
Sanjai R.
Kharkai R.
Chakardharpur Stn.
Lota Pahar Stn.
Porahat
Sonua Stn.
× Sausal Au Pb
Chaibasa 745 Dh
Matkamhatu Mn
Mn
Gitilpi Mn
Kalenda Mn
Bistampur Dh Mn
Kumsi Buru Cr
Kitta Buru Cr
Jojohatu
Chitung Buru 1872 Cr
Roro Buru Cr
Goilkera Stn.
Pahardiah × Au
Mn Leda Buru 2077
Posoita Stn.
Karo R.
Deo R.
Koel R.
Manharpur Stn.
Jaraikela Stn.
Bisra
Ankua Au
Buda Buru 2738
Fe range
Koina R.
Fe range
Notu Buru 2576
Iron-ore range
Jamda
Gumaria
Baitarani R.
Jointi
f f
23° 0′ 85° 15′ 30′ 45′ 86° 0′ 15′ 30′
45′ 30′ 15′
22° 0′

INDEX.

🟧	6. Laterite and alluvium.
▨	5. Cuddapah.
🟩	4. Epidiorites.
▨	3. Granites, granophyres & gneisses.
🟥	2. Peridotites.
☐	1. Dharwarian.
....	Geological boundaries.
f——f	Fault.
- - - - -	Trap dykes.
— — —	Copper-zone.
—·—·—	Iron-ore range (Fe)

MINERAL DEPOSITS IN ORDER OF AGE.

	6.	Alluvial gold (not shown).
× Mn	6.	Manganese-ore.
	5.	Limestone (not shown).
× Au	4. or 3.	Gold.
× Pb	4. or 3.	Lead-ore.
⊗ Cu	3.	Copper-ore.
⊠ Ap	3.	Magnetite-apatite-rocks.
× W	3.	Wolfram.
× Mica	3.	Mica.
× Cr	2.	Chromite.
× Fe	1.	Iron-ore (secondary in part).

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Heliozincographed at the Survey of India Offices, Calcutta.

galena and gold); Sikkim (copper, iron, lead, zinc, bismuth, antimony, tellurium, cobalt) and Kolar (gold with very subordinate sulphides) seem to owe their present position to the intrusive action of granitic magmas, which are supposed to have provided the metals as end-products on cooling.

Noticing the wide tracts of the Peninsula of India occupied by acid gneisses and granites and the comparative scarcity of epigenetic metalliferous deposits, I have suggested the necessity of distinguishing between primary granites discharging their metalliferous burden into the intruded rocks, and secondary or refused granites or gneisses, which are relatively barren as factors in ore deposition owing to the fact that their surplus metals, mineralising agents, and magmatic waters were discharged at the time of the original intrusion. Conversely, the association or otherwise of epigenetic ore-deposits with granitic and gneissic batholiths in India may, on this hypothesis, serve as an index in determining the primary or secondary character of such batholiths.

Ore-deposits and minerals of economic value are comparatively scarce in the Eastern Ghats type of Archaeans, but mention may be made at this point:—

(1) of the manganese-ores formed by alteration of the rocks of the kodurite series;
(2) of graphite, which may occur in the khondalite series;
(3) of quartz-magnetite-ores and small segregations of ilmenite associated with the charnockite series; and
(4) of the monazite of Travancore, associated with pegmatitic intrusions in the charnockite series, but perhaps also occurring in this series itself.

EXPLANATION OF PLATE.

PLATE II.—Geological sketch map of Singbhum showing mineral deposits. Scale 1 inch = 8 miles.

The pegmatites considered as an index to the age of some of the unfossiliferous rocks in the Indian Peninsula.—*By* E. VREDENBURG.

Reasons are given for believing that none of the Peninsular pegmatites are newer than the termination of the Dharwar period. In some instances where doubt has been experienced as to whether certain rocks are of Dharwar or post-Dharwar age, the presence of pegmatite veins would fix their reference to the Dharwars.

The distribution of ores of tungsten and tin in Burma.—*By* J. COGGIN BROWN *and* A. M. HERON.

The increased demand for tungsten caused by the war has resulted in the increased exploitation and prospecting of the wolfram deposits of Burma; cassiterite, being intimately associated with wolfram, has shared in the same activity. In this paper, the authors limit their observations to geological and mineralogical data and give a general idea of the situation, characteristics, and mineral associations, of the wolfram and cassiterite lodes.

They show that all the wolfram and cassiterite lodes in Burma are closely associated with an intrusive granite found throughout the province from the vicinity of the Southern Shan States to the extreme limit of the Mergui district forming the cores of the mountain ranges known as the Indo-Malayan system. The granite is of a very acid type and of a remarkably constant composition and texture throughout the great distances it covers. It has been intruded into a series of ancient slates, argillites, clay-schists and silicified tuffs with subordinate quartzites and conglomerates of unknown age, known as the Mergui Series in the southern districts of the Tenasserim Division. The ores of tungsten and tin, which are such characteristic minerals in the lodes associated with this granite, have unquestionably been introduced from the granitic magma. Some of the sources of these ores are pegmatites and greisens, and this fact is held to give a clue to the presence of the same minerals in true quartz lodes of the ordinary type.

Whilst the detrital or alluvial deposits occurring on hill slopes adjacent to the parent lodes may carry both wolfram and cassiterite, the true alluvial deposits as a rule carry cassiterite only, wolfram being found only when tightly enclosed in a matrix of quartz. This is due to the perfect cleavage of the wolfram resulting in its ready disintegration on movement, with production of a comminuted form eminently suited for chemical decomposition.

In different parts of Burma the mineral association of the ores is not the same. Beryl has only been found at Byingyi in the Yamethin district. At Mawchi in Karenni, in Thaton, and in parts of Mergui tourmaline occurs, but it is unknown in the Tavoy lodes where fluorite has a wide though scanty distribution. The statement that the lodes of Tavoy are characterized by the occurrence of tourmaline and columbite is incorrect. The association of wolfram and cassiterite, with large quantities of pyrite and with smaller amounts of other natural sulphides in nearly every known locality, is a remarkable and significant fact.

Finally, the authors point out that there are vast tracts of country lying between the known deposits of Burma which have been very imperfectly explored, and that the most promising situations in which to find new lodes lie in and about the contacts of the smaller and narrower granite intrusions, especially where patches of sedimentary rock still remain on their surfaces and prove that denudation has not removed the upper contact zone and the underlying portions of the granite itself.

Some saussurite boulders from Kashmir—A study in saussuritisation.—*By* D. N. Wadia.

The writer describes a number of snow-white boulders of saussurite, derived from the metamorphism of an original coarse gabbro (euphotide). The chemical and microscopic study of these boulders reveals an interesting series of mineral changes, commencing with the scapolitisation of the coarse felspar phenocrysts into meionite (sp, gr 2·74), the alteration of this to a dense cryptocrystalline zoisite aggregate (saussurite), (sp. gr. 3·0), which in turn is observed to change completely into grossularite (sp. gr. 3·5). The ultimate product in this series of alterations is a dense, compact eclogite-like rock, composed wholly of garnet with subordinate inclusions of epidote (clinozoisite) and some actinolitic hornblende. The stages in the alteration—both the typical secondary products formed, as well as the transitional stages in the process—are clearly seen in the specimens and micro-sections. The associated ferric minerals of the original gabbro (diallage mostly) have changed to uralite, thence to serpentine and bastite.

These observations support Weinschenk's conclusions that eclogites result through the intense contact and dynamic metamorphism of gabbroid rocks as an end-product of the changes initiated by saussuritisation.

On the discovery of basic and ultra-basic members of the Charnockite series in the Central Provinces.—*By* K. A. K. HALLOWES.

Since the date when Sir T. H. Holland discovered and described the Charnockite Series in several places in S India, naming them after Job Charnock, the founder of Calcutta, other observers have met with them both within and without the limits of the Indian Empire.

T. L. Walker found the basic group of the Charnockites represented in the Kalahandi State, and also in Ganjam and Vizagapatam.

Outside India, quartz-norites, belonging to the basic group of the charnockites, from the Ivory Coast, French Guinea, and Liberia, were described by Lacroix in 1910; still more recently J. W. Gregory, while exploring the geology of Benguella in W. Africa, discovered members of the basic group of charnockites, which have been microscopically examined by G. W. Tyrrell, who finds them to be hornblende-augite-norites.

To the above localities for the charnockite series the writer is now able to add the discovery made during 1917-18, of basic and ultra-basic members of the series in the Central Provinces, where they were not before known to occur: at several points along the Wainganga River Valley, in the districts of Balaghat, Bhandara, and Chanda, are exposures of these rocks, intrusive into hornblende and biotite gneisses.

They consist of (1) biotite-norites, (2) augite-norites, (3) garnetiferous-augite-norites, (4) hornblende-augite-norites, and (5) pyroxenites.

These are composed of hypersthene, monoclinic pyroxene (pale green diopside), felspar (orthoclase, microcline, and labradorite), and quartz, along with the accessory minerals garnet, biotite, secondary hornblende, apatite, black iron ore and iron pyrite.

Some recent falls of aerolites in India.—*By* H. WALKER.

The paper places on record the known facts concerning the falls of four aerolites. Descriptions of the meteorites are given and they are assigned to their places in the systematic classification.

Two aerolites fell in India during the year 1916. Of these the first fell at Sultanpur, a village in the Bollia District of the United Provinces, on the 10th July. The total weight of the material retrieved is 1,710·57 grammes and this weight is apportioned between five pieces. The second aerolite fell on the 21st November in Rampurhat town in the Birbhum District. It is an almost complete specimen with a weight of 99·93 grammes.

In 1917 two aerolites fell in India. One fell at Ranchapar, Sonthal Parganas, on the 20th February. Four pieces were recovered of a total weight of 366·87 grammes. The other aerolite fell on the 3rd July at Cranganore in Cochin State. 1,460·24 grammes of material have been received by the Geological Survey and this weight is divided amongst six fragments. The paper is illustrated by photographs.

A short sketch of the geology of Travancore and its mineral resources.—*By* I. C CHACKO.

Travancore may be divided longitudinally into four zones, of which the easternmost is the broadest, and consists of crystalline rocks, chiefly leptynites and members of the charnockite series, with dykes of norite and dolerite. This zone occupies the western slope of the Cardamom

Hills and contains the most elevated ranges and hills of Travancore, Anamala, the highest peak, rising to about 9,000 feet above sea-level. West of this lies the zone of residual laterites rising to not more than 300 feet above sea-level and sloping gently towards the coast. Next comes the zone of sedimentary beds known as the Warkala (Warkalli) beds. Finally there is a coastal zone consisting of recently silted river mouths, which a few centuries ago was a miniature Sunderbans.

The author takes the opportunity of discussing the definition of the word laterite and also gives an account of the occurrences in Travancore of deposits of monazite, graphite, mica, and of sulphides of iron and copper.

Sedimentary origin of the Dharwars.—*By* A. Ghose.

The author refers to the divergent views at present held by Indian geologists concerning the origin of the rocks of the Dharwar formation. According to the geologists of Mysore, these rocks are, without exception, of igneous origin, the pebbles being mere crush conglomerates; but according to investigations carried out in other parts of India, many members of the Dharwar formation should be regarded as of sedimentary origin. Structural and petrological evidence being apparently insufficient to supply conclusive evidence as to the sedimentary origin of this ancient series of rocks, the author refers to evidences of possible organic life, particularly to carbonaceous material and to presumed contemporaneous iron-ores and manganese ores, and also to certain markings on phyllites from Sandur, which may possibly be either tracks or impressions of organisms.

Note on "lavas" formed by the burning of Coalseams.—*By* L. L. Fermor.

In a note read before the Mining and Geological Institute of India a preliminary account has been given of curious scoriaceous rocks and breccias produced by the fusion of the shales and sandstones associated with coalseams, when the latter catch fire at the outcrop. A microscopic study of these rocks has since been carried out and has revealed the presence of cordierite, sillimanite, fayalite, pyroxene, plagioclase, and iron-ore, typically as porphyritic crystals in a glassy base. There are many varieties of these rocks dependent on the composition of the materials subjected to fusion; but, generally speaking, they may be described as vitrophyres, qualified by the names of predominant minerals such as cordierite-vitrophyre and sillimanite-vitrophyre.

A peculiar limestone from South Travancore.—*By* K. R. Krishna Iyer *and* I. C. Chacko.

The authors describe a peculiar limestone from the Aramboly Pass in South Travancore. The rock contains from 4[illegible] to 60% of carbonates, of which the major portion is calcium carbonate, together with grains of garnet, quartz, and iron-ores. The rock also shows a gneissic structure and appears to have been formed in the belt of weathering by the metasomatic replacement by means of calcium carbonate of the felspars of an original leptynite.

On the remains of carnivorous dinosaurs from the Lameta beds at Jubbulpore.—*By* C. A. Matley.

Since his announcement at the last Congress of the discovery of bones of herbivorous (sauropod) and carnivorous (theropod) dinosaurs near Jubbulpore the author has made another brief visit to the locality and found further remains of both groups of dinosaurs, of which he has made as yet only a preliminary examination.

A considerable portion of the skeleton of a carnivorous dinosaur has now been obtained, though unfortunately much of the material is broken. It includes a cranial bone, parts of the upper and lower jaws and detached teeth, about 30 vertebræ (mostly caudal and ranging with interruptions to the tip of the tail) some chevron bones, a few ribs, several limb bones, including a femur, tibia, fibula and humerus, carpal bones, metacarpals or metatarsals, 5 ungual phalanges and 8 other phalanges. There are also a large number of dermal plates, mostly small, of which nearly 500 have been collected.

A few parts of a second individual were also found at the slightly higher horizon which yielded *Titanossaurus indicus* last year. They consist of two teeth, three ribs and a vertebra.

The interest of these specimens consists partly in the fact that the only carnivorous dinosaurian remains hitherto found in India are a few teeth ascribed to *Megalosaurus* sp. and partly in the discovery of the dermal plates. Apparently only one instance of a carnivorous dinosaur being protected with dermal armour has hitherto been known. This is the type specimen of *Tyrannosaurus* (*Dynamosaurus*) *imperiosus* from the Cretaceous rocks of Wyoming.

The reptile appears to have been 20 feet or more in length, of active habits with hollow well-fitted bones, a long flexible tail, sharp cutting teeth, claws and strong hind limbs. It was probably adapted for running. The teeth are megalosauroid but it does not belong to the genus *Megalosaurus*.

Notes on the Panchet reptile.—*By* H. C. DAS-GUPTA.

This paper is divided into two parts. In part I a few bones of the celebrated Panchet reptile obtained from the neighbourhood of Asansol are described, and in part II the question of the systematic position of the reptile is reviewed, as, of late, doubts have been raised regarding its dicynodont nature. The conclusions arrived at by the author may be summarized as follows :—

(1) An examination of all the materials available shows that though, without the discovery of an entire skull, the zoological position of the Panchet reptile cannot be definitely settled, there is no reasonable ground to suppose that Lydekker was mistaken when he placed the Panchet reptile under his new generic name *Ptychosiagum*=*Ptychognathus*, Owen. The only other genus with which some of the Panchet bones agree is *Oudenodon*, but the presence of tusks shows that it cannot be assigned to that genus.

(2) Some of the Panchet reptilian bones appear to have been wrongly identified previously, and the restoration of the pelvic girdle may possibly be modified.

(3) Only one species of the Panchet reptile is known, and not two as suggested previously.

(4) Following the rule of priority, the Panchet reptile should be called *Lystrosaurus orientalis*.

(5) We are still in doubt regarding the habits of *Lystrosaurus*.

Note on a mammalian fossil from Bhavanagar (Kathiawar).—*By* H. C. DAS-GUPTA.

In this paper the author has described a mammalian humerus obtained at Hathab. The fossil is fragmentary, and no generic determination is possible. It is, however, interesting as being the first record of a Gáj mammal obtained in Kathiawar.

On the Inclination of the thrust-plane or reversed fault between the Siwalik and Murree zones of formations, near Kotli, Jammu province.—*By* C. S. MIDDLEMISS.

Describes, by reference to data derived from geological details laid down on the new 1″=1 mile contoured sheets by the Survey of India, the accurate angle of inclination of the above, a result which is widely different from what has generally been assumed in similar Sub-Himalayan sections elsewhere.

The succession of the tertiary marine faunas in the East Indies, based principally on a study of the siphonostomatous gastropods.—*By* E. VREDENBURG.

A detailed analysis of the molluscan fauna clearly settle the lower eocene of the Ranikot of Sind, the upper limit of which corresponds with the Cuisian. It is equally certain that the Khirthar is the equivalent of the Lutecian. The intercalation of a well-developed stage, locally termed the Laki, indicates that the Indian sequence contains an additional term missing, or imperfectly developed, in the classical exposures of the Anglo-Parisian region. Reasons are given for considering it equivalent to Lemoine's "Laonnian" of the Paris basin, and to the Lybian of Egypt. This stage appears to be well developed in the Mediterranean countries where it has been mistaken sometimes for the lower eocene, sometimes for the Lutecian. The Bassein stage of Burma is upper eocene and corresponds with the Nanggulan Series of Java.

The Nari fauna coincides largely, on the one hand, with the oligocene fauna of Europe, on the other hand with that of the Yenangyaung stage (amended) of Burma, whose oligocene age is thereby established. In a similar way has been established the lower miocene age of the Gáj fauna, and its synchronism with the Prome stage of Burma, and with the Rembang and Njalingdun series of Java. Typical marine representatives of the "upper miocene" (mainly vindobonian) Tjilanang series of Java are not known in India. The Mekran and Karikal faunas of India closely correspond with the pliocene Sonde series of Java.

Two new fossil localities in the tertiary rocks of the Garo Hills.—*By* E. S. PINFOLD.

The fossil localities described are on the southern borders of the Garo Hills; the first is four miles north of Dalu on the road to Tura and the second is one mile southwest of Bagmara and about half a mile west of the Summessary River. Although the localities are thirty miles apart the conditions of occurrence are similar and most of the species are common to both; it seems reasonable to assume therefore that the fossiliferous bed in the two localities is of the same age. The absence of similar beds from the intervening sections examined may be due to the poor state of exposure—most of the area in which the rocks might be expected to occur is under alluvium.

The rock containing the fossils is a blue shale with thin concretionary hard bands. The fossiliferous zone in both localities is not more than two feet in thickness and in each case only a single fossiliferous band was observed. This was crowded with fairly well preserved shells, chiefly gastropods and lamellibranchs. The horizon is near the top of the sandstone and shale series which overlies the nummulitic limestones. The prevailing dip is southerly and the occurrence of the fossiliferous bed at the southern border of the hills indicates a position amongst the highest rocks exposed in the Garo Hills.

Mr. Vredenburg, who has kindly undertaken to examine the fossils, reports that there is every reason to conclude that the rock in which the fossils occur is contemporaneous with the Gáj of Western India and therefore lower miocene in age. Rocks of this age have not previously been recognized definitely from any part of Assam.

Note on the marine fossils collected by Mr. Pinfold in the Garo Hills.—*By* E. VREDENBURG.

The fossils collected by Mr. Pinfold consist chiefly of gastropods and lamellibranchs, the greater proportion amongst which are specifically undeterminable. Amongst the forms sufficiently well preserved for identification, some represent species hitherto undescribed, while the majority are specifically identical with shells characterizing the Prome beds of Burma, equivalent to the Gáj of Western India and "lower miocene" of Java. There is every reason to conclude that the strata containing these fossils are contemporaneous with the Gáj of Western India, and therefore lower miocene in age.

Section of Medical Research.

President—LIEUTENANT-COLONEL W. GLEN LISTON, *C.I.E., M.D., D.P.H., I.M.S.*

Presidential Address.

"THE NEXT WAR." MAN *versus* INSECTS.

I have much pleasure in welcoming you to this first meeting of the Medical Research Section of the Indian Science Congress. It is surely a good omen that this section of the Congress holds its inaugural meeting at the close of the Great War. Men's minds and thoughts have been concentrated for four long years on devising means and methods of winning the war. Enormous sums of money have been spent in attaining this end and countless lives have been sacrificed in the great struggle. But now all is changed. Attention is directed to the repair of the damage which has been wrought. The air is full of schemes for reconstruction. Energy is now turned away from creating appliances for destroying human life and is devoted to planning measures for conserving it. One war has ended but another has begun. Men have ceased to kill each other and are now taking cognisance of their common foes.

The last war was won after many painful failures; success has only been attained after careful preparation and qualification for the task—a task which was at first greatly underestimated. Let us hope that the lessons we have learned will fit us for that Next War, which is the subject of my address today; it is a war against insects and disease.

The title of my address is borrowed from an article which appeared some months ago in the "Nineteenth Century Magazine" by Sir Harry Johnston in which he pleaded for a wider knowledge of the subject of Entomology. He drew attention to an excellent popular account of the subject contained in a book entitled "Insects and Man" by Mr. Eland and he says, "All public servants of every degree and every branch of state employment should pass an examination in this work or in the more detailed, more abstruse studies from which it is derived." He shows how necessary this instruction is in the following words: "The frightfully damaging part that can be played by insects in all the crises of humanity, in all extraordinary conditions of life, is brought home to us by the present war. The drawing together of men from the humblest habitations in the kingdom has caused the comfortable living amongst the middle and upper classes to realize our national crime in having so long tolerated the shocking housing conditions of the mass of our people"......"life under these conditions," he continues, "results in able-bodied men and women being carriers of bugs, fleas and lice either on their persons or on their garments or belongings. Immediately following this discovery comes something worse than sleepless nights from the attacks of vermin, comes illness, perhaps death from insect-conveyed diseases. This misery of vermin will at any rate stand out prominently amongst the many forms of wretchedness caused by the present war." "I well remember," he says, "when war was first declared and recruits began to flock into the barracks and the depôts, in an old grey Sussex town, the horror inspired amongst those who were new to the Army by the blankets served out for the recruits to lie on, or to serve as bed coverings. They were found to be swarming with lice and bugs. Such a condition had not seemed of any importance to the quite unsqueamish non-commissioned officer of the type in charge of military stores, and a matter of no moment to the higher placed official whose department at the War Office superintended military equipment. We can most of us remember the real good done to some of our London and provincial prisons by the first imprisoned suffragettes, who, as soon as they were released, spoke of the cockroaches, the bugs, and the lice tolerated in His Majesty's gaols, all of them in some way or another conveyers of disease."

Truly the old proverb "To be out of sight is to be out of mind" could not be more fittingly applied to any other condition of life. Those who dwell in high places know very little about the torture and suffering of the poor; they may strive to do many things for them, but they do not know how to bring health and happiness into the lives of the humble. In short, as Sir Harry Johnston says, "for the Next War as for that we are now waging against a human enemy of civilisation and happiness we must be equipped with a modern and essentially practical education." We may not all perhaps agree with Sir Harry when he suggests that "the whole curriculum of our schools wants overhauling and that instead of Euclid should be taught Entomology or the science of insects; instead of puzzling over Algebra boys and girls should be well-grounded in elementary zoology, botany and chemistry"; but most of us will be in sympathy with him when he remarks that "no farmer should be allowed to farm who cannot satisfy a county board that he understands the elements of hygiene and the cause and effect of disease generated in manure and farm-yard filth. This very filth is misplaced energy which should be stimulating crops, not poisoning food, drinking water, and the blood in our veins. Eventually," he continues, "we shall conquer if we realize in time the seriousness of this war against the Arthropod; as no doubt we shall get the better of the Teuton and the Magyar if we brush aside half-measures and cease to tolerate incompetency, inadequate education and the evasion of responsibility."

Gentlemen, we have won what has been called the Great War because we learned the truth of this last statement and acted on it. Will we in India learn the necessity of acting likewise in order to win the Next War, the war against insects and disease? This is a war against a foe which has inflicted more misery and suffering than the ruthless enemy that has been overthrown in the great war which has just ended.

I have given to insects the first place among our enemies because, in India at least, two-thirds of the preventable diseases can be attributed to their agency. It is for this reason perhaps, that during twenty-years of my service in India much of my time and attention has been devoted to researches connected more or less directly with insects. I very well remember while on my first voyage to India reading of Ross' great discovery—the share which mosquitoes take in the spread of malaria. I had then quite recently completed my college course but had little practical knowledge of insects. I had learned how insects were divided into a number of groups, I had learned that they had six legs and that many of them went through a complete metamorphosis during their life, but I had no idea what a mosquito was like, nor did I know anything of its life history. Although I sought for literature on the subject, I was nearly two years in India before I discovered Dr. Christy's little book on mosquitoes. Subsequently I obtained Colonel Giles' work and entered into correspondence with him. From his private means he supplied me with an outfit for collecting and preserving mosquitoes; he thus encouraged me to take an interest in the subject so that when I was transferred to Ellichpur, a very malarious station, to take medical charge of a regiment and a small civil surgeoncy, I was able to discover a number of new species of Anophelines. I had an opportunity to study the habits and breeding places of this malaria-carrying group of mosquitoes and in due course submitted a report, through the usual official channels, recommending measures for the destruction of fever-carrying mosquitoes by training the river which passed through the Cantonment. I also suggested that a part of the hospital should be protected by wire gauze to prevent mosquitoes becoming infected by biting patients suffering from malaria. Nothing came of this report but some time afterwards the P.M O., or Principal Medical Officer as he was then called, came to stay with me and I availed myself of the opportunity to ask him about the report. He was very candid with me and told me that my proposals were much too costly to be undertaken ; he described how, when his head clerk, who had not been accustomed to receive such an elaborate report, asked him what was to be done with it, he replied "File it, Bacharam." That was my first experience of research in India.

My ardour might have been damped had I not shortly after met Stephens, Christophers and James who were working at malaria under the auspices of the Royal Society of London and who had independently discovered some of the same species of anopheles in other parts of India which I had found in Ellichpur. A very successful conference organized by that enthusiastic member of the Indian Medical Service, Colonel Buchanan, closed for the time being my work in connection with mosquitoes.

I next transferred my attention to plague, and, being greatly impressed with the work of Ashburton Thomson in Australia, tried to learn something about fleas. It was not till I arrived in England on leave some time later that I obtained an introduction to the Hon'ble Charles Rothschild, from whom I was able to learn something about these insects. After my return to India, when on the point of attaining success in this new line of investigation, I was transferred from Bombay to the other side of India. A little later I again returned to Bombay and continued my researches on rats, fleas and plague during such time as I could spare from my duties in connection with the reorganization of the method of manufacturing anti-plague vaccine. Colonel Bannerman, who was then the Director of the Laboratory at Parel, fought hard to secure a small sum of money to build godowns in which to carry out certain experiments connected with plague. About this time Dr. C. J. Martin passed through Bombay on his way to England; he was impressed with the work he saw at Parel and gave me much encouragement. A little later an official in high authority passed through Bombay from Simla on his way home. He too had an opportunity to see what had been done, but, having sat on a stool on the Elysium heights, he believed he knew more about plague than the men on the spot and threw cold water on our schemes. In time, however, the godowns were sanctioned but they were not completed till the Plague Research Commission was appointed. This Commission worked under the auspices of an Advisory Committee in England which was furnished with funds by the India Office. Dr. C. J. Martin, who had much to do with the initiation of this scheme and with the selecting of the workers, chose an admirable team, each individual was endowed with different qualities and the whole team made a splendid working party under the leadership of the late Major Lamb. The Advisory Committee never failed to comply with all reasonable requests for financial assistance made by the workers in India. The workers themselves decided to co-operate together and publish all their work in the common name of the Plague Research Commission. The result of this Commission's work is well known to you all: through their efforts more is known about plague than probably any other disease.

I have taken the liberty of recounting some of my personal experiences in connection with research, for I think valuable lessons can be drawn from them. It was obvious some years ago that the Government of India took little interest in research: the success of the Plague Research Commission, however, did much to change this attitude. The Research Fund Association has been established and is supported by Government. The funds are distributed on the advice of a Scientific Advisory Board which came into being shortly before the war. The activities of this Association have been somewhat hampered on account of the war but good work has been accomplished. Reorganization is contemplated which will result in closer co-operation between the different branches of medicine. Reviewing some of the work of the Plague Research Commission at a very similar gathering to this held in Bombay in the year 1911, I said:—"It will be convenient in a brief review of this kind to consider separately the work done in the laboratory and that accomplished in the field and in the hospital. These different departments of the work, however, cannot be regarded as distinct from one another, any one branch of the work could not be pursued profitably without the assistance and co-operation of the other. We have referred to this matter because we think it is one which should be seriously considered by this Sanitary Conference. It appears to us that at the present time in India there is too great a tendency to confine work and workers to special departments so that there is an absence of mutual co-operation in the different departments—the sanitary, the bacteriological and the clinical branches of our profession are becoming too specialised. There can be no reason why a sanitary officer should not be a good doctor, and we are certain that neither the sanitary officer nor the clinician can carry out their work successfully unless they are bacteriologists. The fruitful work of the Plague Research Commission has been largely due to the fact that the laboratory work has been combined with work in the field and in the hospital."

But, Gentlemen, co-operation is not enough. During the course of the late war we frequently heard that what was wanted to win the war was "men, money and munitions." Well, that is exactly what is wanted to win the Next War.

Men are wanted; but even more than men, leaders of men are required. We want generals and particularly A General. The army of the Medical Profession is an undisciplined army without unity of command. This is eminently true of that branch of it which is concerned with research. In this force each individual works on his own; there is not enough platoon and company training; there is little *esprit de corps*. One man hurries into print because he has done a little piece of work, another hastens to let the world know that he has made a particular discovery first. A body run on these lines is a mob not an army; the leaders, if there are any, are the men who shout the loudest, who beat the big drum; they are often not the men who do the best work. The system of publishing papers in an unlimited list of journals and, that veiled form of advertising, the systematic distribution of reprints, calls for reform. The publication of carefully prepared reviews within recent years has made these methods of communicating information unnecessary. Work ought to be suggested, encouraged, developed and judged by experienced leaders. Post-graduate schools must be founded to train men and work them in teams. Progress in medicine is so rapid now-a-days and the field of work is so extensive that post-graduate study is essential. I am of opinion that any credit for successful work should go to the post-graduate school, not to the individual men who do the work. The units in the Army do their work, not for self-glorification, but for their regiment. Of course, in exceptional circumstances, an individual may be rewarded but the reward should come through his school and not through the press. The men in the school are best fitted to know the true value of any worker. These post-graduate schools must not confine their attention to one particular branch of medicine but, to be successful, they should include on their staff, hospital, laboratory and field workers; they should train men in all branches of medicine, and those scholars who show the greatest aptitude for a particular line of work should be selected for that work.

Money will be required. This is the most necessary item in carrying on the war against disease. Without money neither men nor munitions can be secured. The amount of money required for any particular work will depend on the magnitude of the work; a proper estimate of the task to be accomplished must be made. Unfortunately in medicine the task is almost always underestimated and in consequence expenditure of the small sums available yield disappointing results. On account of our limited resources an attempt should be made to concentrate the fighting; guerilla warfare is only adopted by the vanquished. As well might we attempt to bund the course of a great river with sandbags as attempt to fight disease with inadequate resources.

The foes we have to fight are invisible and well entrenched, their movements are strictly secret. Research workers will form our air force; they will observe the effect of our fire and co-ordinate all our movements. The Sanitary staff will form our artillery; they must be overwhelmingly strong to encompass our enemies. They must be able to lay a barrage against the advance of our foes or prepare the way for our infantry which will constitute our main strength. Our infantry is the great body of general practitioners.

On a single occasion only, in the history of medicine in India, has an adequate measure been made of the task which had to be accomplished in fighting a disease; that occasion was the introduction of vaccination for the prevention of small-pox. A scheme was then thought out and money was provided. Even now more than half of the total sum expended on the prevention of disease in rural India is absorbed in fighting this one disease. The fight has been fairly successful but there are many other diseases to be fought and the funds available are insufficient to deal with them all. The prospect of success would be brighter if more money was forthcoming for the fight but with limited resources efforts must be concentrated on one or two diseases only. The diseases which are transmitted by insects are eminently suitable for selection. Malaria, plague, typhus and relapsing fever, to mention only a few insect-transmitted diseases, were at one time common in Europe; they have been practically banished from these shores. It is not an impossible task to banish or at least greatly lessen the prevalence of these diseases in India which claim annually more than a million lives.

But, again, let me say, we must thoroughly understand the strength of our enemy and our preparation and resources must be ample to maintain the struggle. In twenty years more than ten million lives have been sacrificed to plague, an easily preventable disease. The economic loss sustained on account of plague can hardly be exaggerated. It cannot be too clearly recognized that money spent on efficient health administration is in a very special sense remunerative.

Munitions are required to win the next war. This is an axiom that needs little explanation. India has been provided very badly in the past with medical munitions. Every medical man should possess a microscope; it is an instrument even more useful and necessary than a stethescope in tropical countries. How few medical men use this instrument; they must learn.

In concluding this address I wish to express the hope that the lessons of the late war will not be lost on the medical and scientific professions. The calling to which, Gentlemen, you and I belong, will provide the soldiers and the generals of the future; and the struggle upon which they are to be engaged will be as glorious as that now so happily past. The object of the late war was the liberation of the world and the triumph of international good faith; the object of the next war is the amelioration of the world and the triumph of organized intelligence. In this endeavour the State and the public are interested as vitally as ourselves, for it is they we serve; but the support of the one and the confidence of the other will be gained only if we, the medical profession, prepare to abandon the futilities and half-measures with which we have been content in the past; if we resolutely determine no longer to tolerate incompetence, evasion of responsibility, or inadequacy of education in our midst; and if we will display in the future a sense of public duty and an appreciation of the magnitude of the task that lies before us, whereby alone we may aspire to greater victories and more lasting triumphs than the world has hitherto seen.

The breeding places of *Phlebotomus* in Lahore.—*By* J. L. Mitter.

The difficulties in locating the breeding places of Phlebotomus are due to the fact that the larvæ and pupæ escape detection owing to their minute size and colour.

The examination of material under a binocular microscope gives the best results and is the only means of securing a larger number of larvæ and pupæ.

The breeding places of Phlebotomus are not restricted to any particular sites in India, such as cellars, rubble walls, caves, latrines, etc., but these flies are capable of breeding in any place where the conditions are favourable.

The necessary conditions are darkness, a certain degree of moisture, and the presence of decaying vegetable matter, which must remain undisturbed for some time.

The conditions of breeding places slightly vary in different species. The *papatasii* require a certain amount of darkness, but this condition is not essential in the case of *minutus*.

The suggestion of Capt. Marett of a host being probable is incorrect, as the whole cycle of development is passed in decaying vegetation and earth.

The results of a mosquito survey of Indore City.—*By* M. O. Tirunarayana Iyengar.

The paper deals with the different breeding habits of mosquitoes found in Indore City and their prevalence in relation with the environments. It also includes an ecological study of the aquatic plant-life and algal-life which to a large extent determine the particular species of mosquito breeding in the water. Other aspects of aquatic biology are also dealt with.

Five Anophelines, namely *Anopheles rossi*, *A. culicifacies*, *A. stephensi*, *A. fuliginosus*, and *A. barbirostris*, breed in the rivers and nallas of Indore in large numbers. There are various causes for such a favourable condition of the waters. Abundance of aquatic vegetation, semi-aquatic and sub-aquatic; Algæ. The different kinds of algæ found in Indore rivers; their distribution in relation to the nature of the water; their importance as providing food and shelter to mosquito larvæ.

Contamination of the river with sullage takes place by the inflow of the City's drains into the river; but such a contamination does not exclude the malarious varieties of the anophelines, as it does elsewhere. This is due to the process of self-purification of the streams as a result of various factors, physical as well as biological; increase of aquatic vegetable growth as a result of the contamination; exclusion of larvicidal fishes.

A study is made of the comparative prevalence of the different species of anophelines in relation to the variation in dissolved impurities in the waters; the rise and fall of the different species as shown by a graph.

The mosquitoes in relation to disease; suggested methods of control; control of aquatic vegetation and algal growths. Experiments on the larvicidal capacity of some Indore fishes belonging to the genera *Haplochilus*, *Barbus* and *Nuria*. A discussion on the usefulness of aquatic birds like ducks and geese.

Hydrocyanic acid gas as an insecticide.—*By* W. Glen Liston and S. N. Gore.

The officers of the Parel Laboratory have for some years been engaged in the study of a variety of insecticides, with the result that a number of useful means for destroying insects have been devised each of which is applicable for use under special circumstances. Of oily contact insecticides kerosene oil or hydrocarbon emulsion have been found very effective. Cunningham's method of killing fleas by laying articles containing these insects on a layer of sand exposed to the heat of the sun's rays has also proved to be very useful. A number of gaseous insecticides have been tested by Gloster, Stevenson, Taylor, Liston and Gore. Of these gaseous insecticides carbon monoxide, formalin and sulphur dioxide were found to be of little practical use while Hydrocyanic Acid Gas, used within the limit of temperature found in Bombay, has been proved to be effective in killing the eggs, larval, pupal and imago stages of insects. Much ingenuity has been expended in devising methods for applying this gas to practical purposes and while much yet remains to be done to perfect the methods, considerable progress has been made.

One of the most important steps in the development of these methods has been the use of solutions of potassium cyanide and sulphuric acid for generating the gas. Experience has shown that the most convenient concentration of these solutions for use is 33·3% strength of each in water. All that is required to effect the convenient generation of the gas is to pour the two solutions into separate vessels and to allow the fluids to mix slowly in an open dish placed within the room. The solutions are passed into the room which is to be treated through tubing and they are allowed to run into the room at the same rate from each vessel. The two tubes conducting the solutions into the room open immediately over the flat dish fixed in the room. The whole apparatus can be fixed to the door of a room as is shown in the plan.

An arrangement of this kind is eminently suitable for small rooms of from 100 to 500 cubic feet capacity but when larger rooms have to be used more elaborate arrangements for convecting the gas through the room are required. The arrangements adopted for a large room for delousing the kit of soldiers is shown in the next plans.

The quantity of chemicals required for one hundred cubic feet of space to be treated are half an ounce each of potassium cyanide and strong sulphuric acid. It is important to note that the potassim cyanide is pure. Under satisfactory conditions where there is very little loss of gas by leakage from the room and when the room is empty, half an ounce of potassium cyanide mixed in this way with half an ounce of sulphuric acid will give approximately 110 parts of HCN per 100,000 parts by volume of mixed gases in the room.

Now it has been found that 30 parts of HCN per 100,000 parts of air within a room will suffice to kill all stages of development including the eggs of bugs and lice provided an exposure of two hours is given at that concentration. It has been observed that when a room is filled with clothing the concentration of the gas very appreciably decreases; it is necessary therefore, when large rooms containing clothing are being treated, not only to convey the gas to different parts of the room but also to provide means for estimating the strength of the gas contained within the room. This has been effected by the arrangement which is illustrated.

Half a cubic foot of the air within the room is withdrawn by means of an aspirator; the air, as it is drawn from the room, is passed through a weak solution of caustic soda. The solution very rapidly absorbs the HCN gas contained in the sample and the concentration of HCN in the solution can be estimated by means of a standard silver nitrate solution using potassium iodide as an indicator. The standard silver nitrate solution is of such a strength that 1 c.c. = 10 parts of HCN per 100,000 parts of air when the quantity of air withdrawn is half a cubic foot. The standard solution is made by dissolving 5·114 grammes of silver nitrate in 1 litre of distilled water.

A series of experiments have been conducted by Dr. Gore with the assistance of Mr. Akula using a small experimental chamber of 200 cubic feet capacity and testing the effect of different concentrations of the gas for different periods on the eggs, larval and imago stages of lice bugs and cockroaches. The results of these experiments are recorded in the subjoined table.

The experimental chamber will be on view at the Conversazione and demonstration of the method of working it will be given.

This gas can conveniently be used for the destruction of bugs, lice and other vermin in beds, in clothing and in furniture. No hospital in India should be without one of these very useful vermin-killing rooms. The method of working is very simple and can be used without danger if attention is paid to certain very elementary precautions.

The cost of treating 1,000 cubic feet of space at pre-war rates amounts to four annas only. The gas has the great advantage that it does not injure the most delicate fabric and does not corrode metals. Small traces of the gas are easily detected by the nose; delicate chemical tests can also be applied. Mammals as compared with many insects are relatively less susceptible to the poisonous effects of the gas. Birds are very easily killed by concentration of the gas which are harmless for men. A sparrow may be used to indicate when a place containing the gas is safe to enter. Inhalations of small quantities of gas for long periods, e.g. when working with it does not cause toxic symptoms. In this latter respect HCN has a great advantage over nearly all other poisonous gases.

The pathogenesis of deficiency disease.—*By* R. McCarrison.

Colonel McCarrison recounts the results of his experiments on feeding pigeons on a diet consisting solely of polished rice; that is to say, on a diet composed mainly of starch, with less than 10% of protein and with complete absence of accessory food factors One hundred and sixty-eight of these birds developed polyneuritis avium within the period of the experiments. The heart's blood and the internal organs of one hundred and forty-two birds so fed were examined bacteriologically at autopsy; of these ninety-four were found to have had concurrent septicæmic infections of various kinds, while the heart's blood and organs of forty-eight were sterile. Four out of one hundred and forty-two had tubercular disease of the lungs or abdominal viscera, or both.

Seventy-two pigeons were employed as controls; the blood and internal organs of sixty-three were examined bacteriologically at the time of death. Six were found to have septicæmic infections of various kinds. Two had tubercular peritonitis. The incidence of tubercular disease in the pigeons employed was thus 2·7%. The organs of a large number of these birds were weighed immediately after death.

The following conclusions have been reached as a result of clinical, anatomical, histological and bacteriological observations:—

1. The absence of certain accessory food factors from the dietary, improperly termed 'anti-neuritic,' leads not only to functional changes in the central nervous system *but to similar changes in every organ and tissue of the body.* The morbid state to which their absence gives rise is not a neuritis.

2. The symptom-complex resulting from the absence of these substances is due (*a*) to chronic inanition, (*b*) to derangement of function of the organs of digestion and assimilation, (*c*) to disordered endocrine function, especially of the adrenal glands, and (*d*) to malnutrition of the nervous system.

3. Certain organs undergo hypertrophy; others atrophy. Those which hypertrophy are the adrenals. Those which atrophy, and in the order of severity named, are the thymus, the testicles, the spleen, the ovary, the pancreas, the heart, the liver, the kidneys, the stomach, the thyroid and the brain.

4. The enlargement of the adrenals is a true hypertrophy in so far as it is associated with a proportionate increase of the glands' adrenalin-content. The quantity and quality of adrenalin in the hypertrophied organ is, area for area, approximately the same as that found in the adrenals in health. The hypertrophy is equally well-marked in both sexes.

5. Œdema has invariably (100%) been associated with great hypertrophy of the adrenal glands, while 85% of all cases having great hypertrophy of these organs had œdema in some form. The amount of adrenalin, as determined by physiological methods, in such cases has been considerably in excess of that found in cases not presenting this symptom, and greatly in excess of that found in normal adrenals.

6. The œdema of inanition and of beri-beri is believed to be initiated by the increased intracapillary pressure which results from the increased production of adrenalin, acting in association with malnutrition of the tissues. Failure of the circulation and venous stasis may subsequently contribute to it. Age is an important factor determining its occurrence.

This finding is held to account in great measure for the occurrence of "war œdema" amongst prisoners of war in Germany.

7. Wet beri-beri and dry beri-beri are essentially the same disease; the former differs from the latter in the greater derangement of the adrenal glands.

8. Gastric, intestinal, biliary and pancreatic insufficiency are important consequences of a dietary too rich in starch and too poor in "vitamines" and other essential constituents of the food. It is suggested that some of the obscure metabolic disorders of childhood might be examined from this view-point as well as from that of endocrine gland starvation.

9. A state of acidosis results from the absence of so-called "anti-neuritic vitamines"; this state is due to the imperfect metabolism of carbohydrates and to acid fermentation of starches in the intestinal tract. Clinically, it is evidenced by progressive slowing and deepening of the respirations.

10. Great atrophy of muscular tissues results from deficiency of accessory food factors; it is due in part to the disturbance of carbohydrate metabolism in consequence of disordered endocrine function, in part to the action of the adrenals in supplying blood to the vegetative organs of the body at the expense of the muscles.

11. Profound atrophy of the reproductive organs is an important consequence of 'vitaminic' deficiency. It leads to the cessation of the function of spermatogenesis. In the human subject such degrees of atrophy would result in sterility in males and in amenorrhœa and sterility in females. This finding is held to account in great measure for the occurrence of "war amenorrhœa."

12. The central nervous system atrophies little; paralytic symptoms when they occur are due mainly to impaired functional activity of nerve cells; much more rarely to their degeneration.

13. It is thought that, because of their atrophy out of all proportion to other tissues, the thymus, the testicles, the ovary and the spleen provide a reserve of accessory food factors for use on occasions of metabolic stress. This reserve, however, is rapidly exhausted.

14. The bones are thinned and there is a loss of bone-marrow.

15. The red cells of the blood are diminished by about 20%.

16. The whole morbid process is believed to be the result of nuclear starvation of all tissue cells. Even the adrenals, which alone of all organs of the body undergo enlargement, show on section changes in some of their cells indicative of nuclear starvation. The so-called "anti-neuritic vitamines" are nuclear nourishers without which cell multiplication does not occur

17. Finally, although deficiency of certain accessory food factors is the essential etiological agent in the genesis of beri-beri, it is held that the infectious and parasitic agencies are often important causes determining the onset of symptoms.

Vitaminic deficiency renders the body very liable to be overrun by the rank growth of bacteria.

Beri-beri.—*By* MAJOR-GENERAL HEHIR.

The paper contains a description of the outbreak of beri-beri that afflicted the British Troops during the siege of Kut-el-Amara which lasted from the 4th of December, 1915, to the 29th of April, 1916. The outbreak was responsible for 155 admissions, all among British Troops. No case occurred among the Indian Garrison who, however, suffered severely from scurvy. The great majority of the beri-beri cases occurred during the first three months of the siege in spite of the fact that the food ration was then superior in respect of quantity and variety than at a later stage of the siege.

The disease as seen in Kut-el-Amara presented no very unusual symptoms: it is interesting however that gastro intestinal symptoms, notably marked distension of the abdomen, were present and persistent in a large proportion of cases. The case mortality rate was 15 per cent. Fifty per cent of the patients returned to duty after an illness of six weeks to two months, and 45 per cent of the cases were invalided.

All but two of the men affected had been in Mesopotamia from an early stage of the expedition: non-commissioned officers and privates were equally affected; there were two cases among British officers. Severe continuous exercise appeared to precipitate the disease in most cases. In a number of cases diarrhœa or gastro-intestinal disturbance preceded the attack.

Most of the cases had suffered previously from malaria, but as few men in the force escaped from malaria altogether this may be only a coincidence: the Indians who had had a higher malarial incidence than the British escaped from beri-beri altogether.

An intimate association between the prolonged use of tinned meat and ration biscuits, or white bread, by British Troops and the occurrence of beri-beri was noted.

The rations issued during the siege of Kut are described. In view of the fact that Indian Troops were very severely effected from scurvy during the month of February whereas the British Troops escaped and that the British suffered from beri-beri, a disease from which the Indians were free, makes a comparison of their diets of peculiar interest. British Troops ate horse flesh; the Indians did not. Indian Troops used *dal*; the British did not. The British used white flour or biscuits for a large part of the time; the Indians throughout ate either *ata* or barley flour. Towards the end of the siege beri-beri disappeared in spite of the fact that the troops suffered from partial starvation. The relatively large issue of horse flesh probably accounted for the disappearance of the disease. Towards the end of the siege the absence of carbohydrates from the diet of British Troops led to reduction in body weight, lowered temperature, slowing of the pulse and marked debility.

The vitamine theory of beri-beri is discussed and the investigations carried out at the Lister Institute by Miss Chick and Miss Hume are referred to in some detail and the author subscribes to the conclusion reached by Miss Chick and Miss Hume that the British Troops were protected from scurvy by the ample ration of meat or horse flesh and that the Indian soldiers, though protected from beri-beri by the nature of their cereal ration, failed to obtain a sufficient supply of anti-scorbutic vitamine owing to their refusal to eat fresh meat.

The rations issued to British and Indian Troops during the three stages of the siege are detailed in an appendix to the paper.

Quinine in the treatment of malaria—what is known and what is not known about quinine.—*By* J. W. CORNWALL.

We are not yet in possession of complete knowledge of the action immediate and remote, of the majority of the drugs which are freely administered to sick people Quinine is no exception. Therapeutic text books dogmatically teach that quinine destroys low forms of animal and vegetable life; that it is a tonic; that it influences metabolism; that it is an antipyretic; that it can affect the circulation and respiration; that it is a specific in malaria, and that it produces numerous minor symptoms.

Pharmacologists teach that it has no tonic effect but is a protoplasmic poison; that it decreases both katabolic and anabolic activity, and by so doing interferes with the proper oxygenation of the tissues and diminishes heat production; that it inhibits all cellular enzymes, and so lessens the needful supply of hormones, and checks digestion and assimilation; that it depresses the circulatory and respiratory mechanisms, and that waste products tend to accumulate as the normal excretory functions are in partial abeyance. In robust health the recuperative and compensatory powers of the tissues enable an individual to withstand a dosage which in a cachectic state would be more than his weakened organs could deal with.

In the treatment of malaria the non-selective, toxic effect of quinine has been largely ignored.

Too much attention has been paid in India to relatively unimportant entomological side issues and too little to co-ordinated scientific inquiry into the pathology of malaria and the pharmacology of quinine.

The following matters call for investigation:—

(1) Whether quinine in harmless doses can act as a reliable prophylactic. If it cannot, its use as such should cease.
(2) Whether malaria can be cured by doses of quinine which, compared with the harmful influence of the parasite, are relatively harmless to the patient.
(3) Whether any useful purpose is served by dosing a patient with quinine between his relapses.
(4) Whether any other drug can be found which will destroy the parasites of malaria without at the same time seriously harming the tissue cells.
(5) Exactly what pathological changes are caused by the malarial parasites.

(6) Exactly what pathological changes are caused by therapeutic doses of quinine—(*a*) in health, (*b*) in cachectic states.

The treatment of malaria by quinine.—*By* MAJOR-GENERAL HEHIR.

The extent to which quinine is curative of malaria has only recently been investigated and recorded scientifically. Careful malarial work has been in progress at home during the war, and the Dagshai Malarial Depôt is carrying out similar work in India. The results of this inquiry, it is hoped, will give some definite information regarding the minimum dose of quinine necessary to eradicate the disease.

The Dagshai Malarial Depôt was opened in April, 1918, for the treatment of chronic malarial infections among British Troops. At first accommodation was available for 45 cases only but now 1,000 can be housed. The first report of this depôt for the period ending the 30th of September, 1918, has just come to hand.

At Dagshai the climatic conditions are very favourable for the treatment of chronic malaria for there are no anopheline mosquitoes there and reinfections are eliminated. Investigations have been concentrated on the treatment of chronic malaria, especially the prevention of relapses by the administration of various quinine salts given in different ways and in varying quantities. All the cases except two were chronic benign tertian infections which had resisted quinine. Investigations were scientifically carried out, well controlled, and carefully recorded. No case was treated till the parasite was found.

The following methods were tried at Dagshai :—

CONTINUOUS ORAL ADMINISTRATION OF QUININE SULPHATE.

(*a*) In doses from 15 to 30 grains daily for periods of 8 to 22 weeks. Out of 73 cases treated 34 relapsed within 4 weeks.

(*b*) In doses of 30 grains daily for 3 weeks succeeded by 15 grains daily for 90 days. Out of 93 cases treated 7 relapsed within 5 weeks.

(*c*) In doses of 30 grains daily for 8 weeks. Out of 91 cases 11 relapsed within 5 weeks.

INTERMITTENT ORAL ADMINISTRATION.

(*a*) 45 grains on two consecutive days weekly for 8 weeks. Out of 101 cases 32 relapsed within 3 weeks. This method was more successful in England as details of experiments carried out by Professor Stevens show

(*b*) 30 grains in 2 doses on two consecutive days weekly for eight weeks. Out of 110 cases two relapses occurred during treatment. It is remarkable that this method should be more satisfactory than the same quantity given daily for 8 weeks. This was the most successful method tried.

Stevens reports two experiments in England on similar lines but using huge doses (90 grains). In one of his experiments 62% did not relapse within 60 days. In a second, 94% relapsed in from 12 to 53 days; the discrepancy is not explained.

INTRAVENOUS INJECTIONS.

The groups of cases treated with intravenous injections are too small to give any reliable results, but as far as they go they indicate that intravenous treatment is unable to check relapses. The method is probably very inferior to either the interrupted oral method *b*, or the continuous oral method *b*, although, on account of the rapidity with which the drug can be brought into contact with the parasite, it is useful in pernicious malaria and might be reserved for intense and dangerous infections where an immediate effect is desired.

INTRAMUSCULAR QUININE.

Twelve injections of bihydrochloride on alternate days combined with 30 grains of quinine sulphate orally on the intervening days and 15 grains of the same salt early on the days of injection. Other methods of oral administration were combined with intramuscular injection. The results show that relapses were not prevented but that the peripheral blood was cleared in 24 hours.

TREATMENT OF INITIAL INFECTIONS.

Initial infections are much more easily controlled than relapses. One of the most important facts demonstrated in recent times is that if initial infections are treated with large doses (30 to 45 grains daily) for a sufficient period (not less than three weeks) complete eradication of the disease may be hoped for in the majority of cases. It is wrong to reduce the dose after the circulation is cleared of the parasites. One may develop in this way a quinine-resistant parasite. Put as much quinine into the system as practicable without injuring the patient, if not orally, then either intramuscularly or intravenously.

In malignant tertian infections give quinine when a large number of parasites in association with concentrated pigment indicate that a paroxysm is about to occur. Quinine should not be given in large doses and for long periods unless it is certain that the patient has malaria and that the drug is doing good. One may do considerable injury to the patient by pushing the drug unnecessarily. The diagnosis of the disease is easy and it should always be made before quinine treatment is adopted.

One must endeavour to avoid the possibility of relapses by early, vigorous and well-sustained treatment. The older the asexual cycle of the parasite associated with a relapse the more resistant it is to quinine. If quinine fails to control parasites in the blood faulty absorption should be suspected. It is possible, though not proved, that the parasite may become immune to the action of quinine, like trypansomes in relation to atoxyl. This assumption emphasises the importance of vigorous treatment of initial paroxysms. Records show that in malarious stations in which curative quinine treatment is most persistently and intensively carried out relapses are decidedly fewer than those in which quinine treatment is adopted in a half hearted way. Evidence is also available that continuous examinations of the blood are necessary in diagnosing malaria. The practice of relying on a single examination is too common. Bloodslides should be made daily until a diagnosis is arrived at.

Figures collected from the Burma Division after this custom was instituted show that out of 750 cases examined 193 were missed at the first examination. In this division the old diagnosis of fever of uncertain origin rapidly gave place to malaria; the same applies to the VIth Division.

DIET.

Sufficient attention is not paid to diet and rest in the treatment of malaria, especially in the treatment of relapses. The system should be well nourished, toned up and adequately rested. Keeping patients in bed for short intervals is useful.

CONCLUDING REMARKS.

Quinine is still the best remedy we possess for malarial fevers. Malaria cachexia is not so frequently seen among treated cases as among an untreated population. Quinine may fail to cure chronic malaria in a certain number of cases, but properly administered, it controls the disease. As we know of no better remedy its value should not on any account be decried. While quinine will cure malaria there is no reason why a search for other drugs for this purpose should not be made. Any new drug is not likely to replace quinine but supplement it.

Some quinine prophylaxis returns from Army Headquarters.—*By* W. W. BROWNE.

The following is a cursory analysis of the returns prepared by the military medical authorities in connection with a scheme to test the prophylactic effect of quinine on malaria incidence in certain stations in India. The figures must be accepted with reserve, since—

(*a*) in many cases the quinine was not regularly administered;
(*b*) no corrections have been applied;
(*c*) the cases have not been examined in detail.

As a matter of interest figures are given to show the incidence of influenza amongst men taking prophylactic quinine and those not taking it.

	Total No. of men dealt with.	Total Malaria cases.	Ratio per mille.
A	2,297	71	24·5
B	3,051	76	24·9
C	3,337	95	28·4
A-1	493	80	162·2
B-1	334	70	208·5
C-1	378	84	222·2

A-1, B-1 and C-1 are men who had malaria within 12 months but were supposed to be cured.

A, B & C had no malaria within 12 months of the commencement of prophylactic treatment.

A and A-1 had 7½ grs. quinine daily during the period of trial.

B and B-1 had 15 grs. quinine on 2 consecutive days weekly.

C and C-1 had no quinine during the period of trial.

Influenza among—	Ratio per mille admissions.
1. Men taking quinine prophylaxis	126·4
2. Men not taking quinine prophylaxis	89·0

A simple method for detecting fæcal carriers —*By* W. GLEN LISTON, and S. N. GORE.

The detection of "carriers" has come to be recognized as a factor of prime importance in any campaign to reduce the incidence of a disease among a community.

At no period in medical history has this method of combating disease been more extensively studied than during the Great War. The opening of an Enteric Depôt at Parel during the War, working in close association with the Bombay Bacteriological Laboratory, afforded a unique opportunity to study the various methods which have been recommended for the isolation of typhoid and allied bacilli from the stools of carriers.

A consideration of the methods generally adopted reveal the fact that most of the special media used for the detection of "carriers" are employed with the object either (*a*) of distinguishing the colonies of typhoid bacilli and its allies from the common organisms found in fæces by certain colour reactions, or (*b*) of encouraging the growth of typhoid bacilli to a greater degree than the other organisms found in the stools. These principles of differentiation and enrichment are often combined in one method and they have always engaged the attention of the inventors of new methods to the practical exclusion of certain more elementary principles of bacteriology.

A prolonged trial of the various methods showed that any one of them was almost as good as any other provided only that discrete and isolated colonies were obtained. Little attention has however been paid to this elementary principle of bacteriology by the advocates of new methods who in the elaboration of the principles of differentiation and enrichment have almost altogether overlooked the importance of securing isolated colonies.

It is unnecessary to take into count the actual number of organisms contained in a given sample when large quantities of elaborately prepared and expensive media are used, but this extravagant method lacks the scientific precision which may be attained if cognisance is taken of the probable number of organisms contained in a given sample.

Preliminary experiments with many samples of fæces showed that the number of ærobic organisms which would grow on ordinary agar varied from one million per cubic centimeter of fæces to one thousand million per cubic centimeter. Similar experiments in which a count was kept of the relative proportion between typhoid and allied bacilli to the common organisms found in fæces were conducted on one hundred and forty samples of stools obtained from nearly forty different carriers of typhoid, paratyphoid A and paratyphoid B bacilli. These experiments showed that out of a total of 140 stools of carriers 95 per cent of them gave a ratio of more than one typhoid or allied organism to twenty common intestinal organisms. Only seven stools or five per cent gave a ratio below 1 to 20 and one sample only gave a ratio of 1 to 31.

It may be stated therefore that for practical purposes, when the stools of a carrier contain typhoid or allied organisms, it will suffice to detect such a carrier, if, let us say, a group of fifty satisfactorily isolated colonies, selected at random, are examined. If among such a group of fifty colonies, there is not one colony like a typhoid colony then no differentiation or enrichment will enable a person to detect typhoid or typhoid-like bacilli in such a natural stool. We are aware that artificially it is possible to add to a stool a number of typhoid bacilli which will make the proportion between these bacilli and the common fæcal organisms such that an examination of fifty colonies only would not suffice to detect them. Our experience however has been that the stool of an enteric carrier, when typhoid or typhoid-like bacilli are present in it, contains when voided so large a proportion of these bacilli that the examination of a group of fifty distinctly isolated colonies planted on ordinary agar will suffice to detect their presence in the stool and that methods involving the principle of enrichment are unnecessary if pains are taken to secure sufficiently isolated colonies.

Bearing this experience in mind and knowing that the variation in the number of organisms found in fæces ranges from one million to one thousand million per cubic centimeter it is only necessary to distribute on dry agar slopes definite quantities of a series of definite dilutions of an emulsion of fæces to secure a sufficient number of isolated colonies. The details of the method which has been found convenient for doing this will be demonstrated by means of the magic lantern. The method is one which can be used by the general practitioner provided he secures some ordinary agar slopes, a graduate pipette marked in fiftieths of a cubic centimeter, a fæces emulsion tube, two platinum loops, some high titre agglutinating serum and a glass plate with hollows or some watch glasses. A little sterile water or salt solution will also be required together with a spirit lamp, some slides, stains and a microscope. These are all materials which should be in the possession of every medical practitioner especially in India.

Enteric carriers.—*By* J. A. Cruickshank, *and* H. M. La Frenais.

The fæces and urine of 1,886 men invalided from overseas for fevers of the Enteric Group have been examined. On the average 6 weeks had elapsed from the commencement of their convalescence when they came under observation.

791 cases had been diagnosed as Enteric Fever.
633 ,, ,, ,, ,, ,, Paratyphoid "A" Fever.
136 ,, ,, ,, ,, ,, ,, "B" ,,
326 ,, ,, ,, ,, ,, Pyrexia of uncertain origin or Enteric Group.

These figures are as accurate as they can be made under the circumstances, but the figure for Enteric Fever is probably too high and that for Paratyphoid "A" too low. There probably are some among our patients who have never suffered from any Enteric Group fever, but these have been excluded as far as possible.

The stool is passed into a sterile bed-pan and emulsified with sterile tap water, plated on to Conradi's medium and all likely colonies tested with high titre serum and sugars. Brilliant Green and other enriching substances were not found to be of assistance in isolating enteric group bacilli.

49 carriers were detected ; of these

34 are carriers of Bacillus Paratyphosus "A."
9 ,, ,, ,, ,, Typhosus.
6 ,, ,, ,, ,, Paratyphosus "B."

All but five of these would be classed as chronic carriers if we take 3 months from the commencement of the illness as the limit of a temporary carrier, but only 13 became true chronic carriers, the remainder ceasing to excrete the bacilli at varying periods up to 9 months from the commencement of the illness. Of these true carriers

8 are carriers of Bacillus Paratyphosus "A."
4 ,, ,, ,, ,, Typhosus.
1 is a carrier ,, ,, Paratyphosus "B."

Two urinary carriers have been detected ; one is a chronic B. Typhosus carrier, and the other a temporay carrier of Bacillus Paratyphosus "A."

The Widal reaction has been done in all our carriers and we found that chronic carriers always give a positive reaction of at least 1 in 40. The temporary carriers give varied result, those continuing to excrete the bacilli for a considerable time usually give as marked a reaction as the chronic carriers.

Carriers are, as a rule, the fittest men in the depôt, but usually at one time or another complain of pain over the gall bladder which in 12 cases have been sufficiently severe to keep them in bed for 3–4 days. Details are given of 3 chronic paratyphoid "A" carriers in which the symptoms were more severe. The excretion of bacilli ceased during the attacks of pain except in one case in which there was jaundice.

The treatment of chronic carriers is still very unsatisfactory. We have tried Brilliant Green by the mouth and injections of milk in some of the intestinal cases and Urotropin in the chronic urinary carrier without any benefit. Vaccines are being tried. Details are given of two cases in which cholecystotomy was performed possibly with good effect.

The precautions taken in dealing with carriers are given. We have had two cases of relapse.

The amœbic dysentery carrier. The effects of the infection on the individual and the community with some observations on its treatment.—*By* W. MacAdam.

1. Two aspects of the problem of the amœbic dysentery carrier are considered :—

(1) The epidemiological effects resulting from the carriers of this infection in a tropical community.

(2) The effects of the presence of this persistent infection on the individual himself.

2. As to the prevalence of amœbic infections among the troops in India and Mesopotamia, 13% to 18% of the men in an unselected series of 946 men who had been invalided from Mesopotamia for an affection other than an intestinal one were found to be carriers of *Ent. histolytica* cysts as the result of one protozoological examination of the stools per man; while in the case of a unit which had never been in Mesopotamia, but had been stationed 9 months in India, since its arrival from England, 9% were found to be cyst carriers out of 216 men examined.

3. In view of this wide prevalence of histolytica infection, evidence is brought forward showing that the detection and treatment of histolytica carriers and the attempted "clearing" of patients convalescing from amœbic dysentery is of very questionable value in the prevention of the spread of amœbiasis while it would be of very doubtful feasibility.

4. Although the necessity for the efficient treatment of cyst carriers from the point of view of public health does not appear to have been proved, yet recent observations go to show that such treatment of carriers is required for the sake of the individual himself, in order to prevent the occurrence of serious illness due to the pathogenic effects of the histolytica infection.

5. Recent methods of treatment of cyst carriers are briefly discussed, and a short account is given of the findings obtained on treating a series of 80 cases with a course of 18 grains of emetine hydrochloride spread over 12 days, 1 grain being given hypodermically and ½ grain orally each day. The results were carefully controlled by a series of 26 protozoological examinations carried out per case after the completion of treatment, while after-history reports for the following 6 months were obtained regarding the health of 73 of the men.

6. The conclusion is reached that in view of the nature of the changes present in the intestine of chronic relapsing dysenteries, it is very doubtful whether the eradication of the infection in such cases can be expected from the administration of emetine in any form or by any mode. Attention should be concentrated on the thorough early treatment, by the combined hypodermic and oral exhibition of emetine, of primary acute attacks and of cyst carriers when the signs and symptoms of ulceration of the colon are so light as to be relatively negligible.

The rat problem.—*By* J. G. C. KUNHARDT.

The rat problem is one of considerable economic importance to all countries, but particularly so to this one, for India is a great grain-producing country. The structure of the houses and the habits of the people favour a large rat population and, moreover, this country has, through the agency of the rat, suffered severely from plague for the past 20 years.

The losses caused by rats come under three categories :

(*i*) Diseases caused by rats, of which plague is by far the most important ; (*ii*) material damage caused by rats, of which consumption of, and damage to, grain and crops are the chief items ; (*iii*) expenses incurred in rat destruction and in anti-plague measures generally, of which evacuation is economically the most important.

In order fully to appreciate the damage caused by rats, the total loss to the State during the past 20 years, calculated on a conservative basis under each of the above headings, may be expressed by a sum of not less than Rs. 1,242½ crores, or £828,000,000. Of this sum £428 millions may be debited directly or indirectly to plague and £400 millions to material damage.

Apart from anti-plague measures, no systematic attempt at the reduction of the rat population has been made by the State or by public bodies with a view of diminishing the enormous economic loss. Rat destruction as an anti-plague measure is, however, carried out on a considerable scale and it is in this direction that most progress has been made in recent years.

A general reduction of the rat population in all areas subject to plague, by means of limiting the shelter and food supply of rats, and by fostering their natural enemies, and by means of traps and, possibly also, poisoned baits, is an ideal always to be aimed at. But these measures offer little prospect of bringing about, at an early date, a *permanent* and universal reduction in their numbers sufficient to influence appreciably the incidence of plague. It may, however, not be impossible to eradicate plague from a large part, if not from the whole of India, by means of *a temporary* reduction in the rat population provided that this reduction is concentrated at the right time in the right place, namely before or during the off-plague season in the comparatively few places which threaten to carry infection over that period. Research has shown that, at any rate in some parts of India, these places can be detected with a fair degree of accuracy and without any great difficulty. If these measures should succeed, then a large part of the rat problem would be solved.

Investigations have recently been conducted with a view of improving the methods of rat destruction. Though incomplete, they have already shown that there is a great variation in the efficiency of rat traps. By minor alterations and adjustments in their structure and by a judicious selection of the substance with which they are baited the number of rats caught in them can be greatly increased.

Up to the present time attention has been paid more particularly to effecting improvements in poisoned baits. Barium carbonate has now been found to be the best poison; three grains of this is sufficient to kill a full-grown *mus rattus*. As an excipient for this poison a plain dough (about 12 grains) freshly prepared from the flour which is in common use by the people of the locality has proved to be the best.

Some of the more important results hitherto obtained in a large series of experiments are summarised in the following tables:—

(*a*) *In Nature.*—Baits made with the same food basis but with different poisons were mixed together and laid in groups in various houses with the following results:—

Baits used.	No. set.	No. taken.	Percentage taken.
Barium carbonate baits ..	282	171	60·6
Phosphorus baits	282	61	21·6
Control baits (no poison) ..	282	155	55·0

(*b*) *In Laboratory.*—The number of rats used in each experiment was 150, i.e. 15 batches of 10 rats each. The baits or foodstuffs in measured quantity were offered simultaneously to each batch of rats in a specially designed cage for a constant period varying from ¼ to ½ an hour as found convenient, The amount consumed in each observation was then noted as follows:—

	Material used.	Offered (grains).	Taken (grains).	Percentage eaten.
1.	Barium carbonate baits ..	4,500	3,920·7	87·1
	Punjab rat-extr. baits ..	4,500	245·1	5·4
2.	Bajri grain	5,400	2,806	52·0
	Wheat grain	5,400	465	8·6
3.	Barium carb. & bajri baits ..	4,500	1,628·7	36·2
	Pure bajri baits (control) ..	4,500	1,506·3	33·5
4.	Punjab rat-extr. & bajri baits	4,500	227·1	5·1
	Pure bajri baits (control) ..	4,500	3,661·8	81·4
5.	Baits without sugar ..	4,500	3,060·2	68·0
	Baits with sugar.. ..	4,500	1,475·3	32·8
6.	New improved baits ..	4,500	2,923·2	65·0
	Old Punjab rat-extr. baits ..	4,500	15·0	0·3

With the rats used (*mus rattus* from Poona City), laboratory experiments thus indicate that the new bait is over 200 times more popular than the old bait formerly used by us, which consisted of a phosphorus mixture, sugar and wheat dough. The cost, moreover, is about one-tenth that of the old bait.

Other results of these investigations show how the efficiency of a baiting campaign can be increased; thus—

(*i*) Arsenious acid was found to be the only poison suitable for use as an alternative to barium carbonate. Of many others tried all proved to be non-lethal to the rat, or, in lethal doses, too unpalatable for use as a bait.

(*ii*) Rats appear to prefer the grain in common use in their particular part of the country. Poona rats prefer bajri, but Madras rats prefer rice and Sholapur rats appear to favour jowari.

(*iii*) It was found that the dough must be freshly prepared for, owing to desiccation or fermentation, the baits deteriorate rapidly, and are practically valueless after the second or third day. The dry mixture of flour and poison, however, though not so palatable as the wet, does not deteriorate nearly so rapidly.

(*iv*) No other foodstuff was found more suitable as an excipient for the poison than bajri dough Any other food, such as meat, fish, milk, ghee, sugar, etc., or any condiment, such as pepper or salt, when added even in the smallest quantities to the dough invariably caused the amount of bait consumed by the rat to be decreased.

(*v*) When rats have access to an insufficient supply of water they generally prefer some green vegetable of fruit to grain. The most popular in this part of India proved to be sweet-potato, melon, cucumber, mango and cocoanut. This information may be of use when trapping or baiting in some localities.

(*vi*) It might sometimes be desirable to ascertain readily if a rat found dead had consumed a poisoned bait; in this case some colouring matter should be added to the bait. The only simple dye, of all those tried, which does not diminish the attractiveness of the bait is $\frac{1}{50}$th grain of Methylene Blue. Though decolourised in the rat's stomach, the colour at once returns on exposing the contents to light and air.

Important experiments are now being conducted at Poona which show clearly that during an inadequate or intermittent baiting campaign, the surviving rats soon learn to avoid a poisoned bait completely. The results of the observations suggest that though baiting is probably more effective when a sudden and temporary reduction in the rat population is desired, traps should be used in addition when a more permanent result is aimed at. Pending further research it would be well, therefore, to make the initial baiting of a place as intensive as possible.

All the above results suggest that methods of rat destruction, especially relating to the construction and baiting of traps and in the making and laying of poisoned baits, have hitherto been almost entirely empirical, and this may explain why rat destruction as an anti-plague measure is still sometimes regarded with disfavour. They certainly indicate that every endeavour should be made to place the entire subject on a more scientific basis at an early date.

It is remarkable that until recently little has been done in this direction. According to figures quoted by various authorities the loss caused by rats in European countries and the United States every year varies approximately from four to eight shillings per head of human population. In India it would appear to be only about two shillings and six pence per head. Taking the latter rate as an average for the whole world the total loss due to rats would amount to over £200 millions annually. It is obvious therefore that a small expenditure directed on improving the methods of rat destruction might effect an immense saving to the human race.

Rat and plague conditions in hutted camps.—*By* J. Taylor.

The conditions which result in the presence of rats and the occurrence of plague in Hutted Camps at the Basra Base correspond in certain points with Indian experience.

The presence of rats in huts is due to either—

(1) Structural conditions, or
(2) Bad conditions brought about by the occupants.

The structure of most of the huts in which the greater part of the Base population is accommodated affords little shelter for rats in the roofs and walls.

The floors in some cases afforded shelter for rats, and where wooden floors were used, rats always established themselves beneath them. Mud floors permitted of rat burrowing, but if huts were cleared out daily, and no boxes, kit, etc., allowed to accumulate, and the floors kept clear, a rat population did not become established to any extent. Cement floors largely prevented rat infestation.

In any hut, even of a structure which normally would provide little shelter for rats, conditions leading to rat infestation were brought about if the hut was allowed to be filled with lumber which covered the floor and was never cleared out.

Instances of rat infestation and plague are given, which resulted from the presence of wooden floors, or from avoidable conditions caused by the occupants of huts.

In the 1918 plague season, there was an extremely small incidence of plague in Hutted Camps except in those which were badly kept and in which rat infestation had been encouraged by bad Camp management.

The measures which are adopted for keeping huts free from rats are detailed. These may be summarised as—

(1) The removal of boarded floors, and
(2) The introduction of a Camp routine which will entail the complete clearance of floors daily, any alterations to the interior of huts being first made which may be necessary to permit of this.

With these precautions, there is little likelihood of epidemic spread in a camp.

The precautions adopted with regard to ration stores are detailed.

Meteorological conditions in Mesopotamia affecting the occurrence of heatstroke.—*By* J. Taylor.

Two severe heat waves occurred in Basra in 1917. Maximum temperatures of 122° F. and 118° F. were reached in the two waves. These temperatures were associated with high maximum wet bulb readings of over 85° F. A temperature of 89·5° F. was reached in one week. 1,601 admissions to hospital occurred in British troops in the year for the conditions classified as "Effects of Heat." Of these 88 per cent occurred in 3 weeks of the first heat-wave and 4 weeks of the second heat-wave. "Effects of Heat" accounted for 54·4 per cent of the total deaths in British troops in the year.

This condition only caused 3·02 per cont of the deaths in Indian troops.

The conditions which appeared to favour the occurrence of heatstroke were a temperature of over 110°F. along with a wet bulb maximum of over 85°F.

The variations of wet and dry bulb maximums over these limits had corresponding effects on the amount of heatstroke, a temperature of over 115°F. being especially dangerous with a high wet bulb.

The weekly maximums of wet and dry bulb temperatures shown on a chart along with the weekly admission rates per mille of British troops and Indians demonstrate the co-relation of heatstroke to these temperature conditions.

It is suggested that when a wet bulb reading of 85°F. or over is reached the amount of evaporation from the body surface which can occur will with difficulty keep the body temperature down to normal when air temperature of 110°F. to 120°F. prevails.

Heatstroke in Basra was most severe when the wind failed entirely, and when a moist south wind occurred. These conditions would lessen evaporation.

In India, temperatures of over 110°F. are frequent, but a large amount of heatstroke is unusual. These temperatures probably occur under very dry atmospheric conditions in India and the onset of the monsoon which would tend to raise wet bulb readings reduces the air temperature.

In Basra there is no monsoon, and the cooling effect is not obtained at a time when a moist wind from the south will raise the wet bulb readings.

Indians suffered much less from "Effects of Heat" than British, probably from their heat regulating mechanism being adjusted to tropical conditions, while most of the British troops who suffered in Mesopotamia had not had previous experience of a hot weather.

The relationship between malaria in Amritsar and previous weather.—*By* G. T. Walker, F.R.S.

In his recent report on malaria in Amritsar, Major C. A. Gill (Lahore, 1917) has pointed out the close relationship between the autumnal fever mortality and the monsoon rainfall. Much work on this subject has been done by Christophers, but at the request of the Secretary, Amritsar Sanitary Committee, a perfectly straight-forward examination by statistical methods of various meteorological factors was carried out by me. This brought out the fact that the rainfalls of June, September and October have little influence, as also the temperature of September; with the rainfall of July and August the mortality of October and November has the very large corelation coefficient of + 0·8, with a probable error of 0·04.

Sodium morrhuate in the treatment of tuberculosis.—*By* SIR LEONARD ROGERS, F.R.S.

The paper includes a description of the preparation of sodium morrhuate from codliver oil and reports of its use in tubercular disease by several workers and evidence that the drug has a destructive effect on the tubercle bacillus in the tissues.

Diagnosis on a large scale in hookworm infection.—*By* CLAYTON LANE.

The most generally reliable means for the detection of hookworm infection appears to be that fairly direct one based upon the finding of the ova in the stool. The most rapid, cheap and effective method of using this, at least in light infections, is by levitation properly performed. Levitation with preserved stools promises to be satisfactory under certain conditions which appear to be simple, but which require confirmation by a larger mass of evidence before they can be finally accepted. Such confirmation would allow a radical change to be made in our diagnostic arrangements, one combining rapidity, accuracy and cheapness to an extent not hitherto possible.

"Is human Bilharziosis likely to spread in India ?"—*By* M. B. SOPARKAR.

In this paper Dr. Soparkar discusses the possibility of the spread of Bilharziosis in India. He summarises the results of recent researches in the mode of propagation of this disease and concludes that this possibility depends upon the existence in this country of suitable molluscan hosts. As to the existence of this disease in India his enquiries show that apart from imported ones, indigenous cases of this disease have, with a few exceptions, not been recorded. If on account of its characteristic symptoms infection with *Sch. hæmatobium* is not likely to be overlooked, the same is not true of infection with *Sch. mansoni*, the symptoms in this case simulate a common disease—dysentery ; while infection with *Sch. japonicum* causes symptoms which simulate chronic Malaria or Kala Azar.

On this account the author suggests that the latter infections might have hitherto been overlooked and emphasises the importance of routine examination of fæces for the detection of such cases.

An examination of sheep and cattle in Bombay has shown that a certain number of them harbour Bilharzia worms of the mammalian type.

Investigations regarding fresh-water mollusca show that species of "*Bullinus*" which are known to carry *Sch. hæmatobium* have not yet been found in India. On the other hand, several species of *Planorbis* and *Melanta* which resemble the carriers of *Sch. mansoni* and *Sch. japonicum* commonly occur in India.

Experimental infection of "*Planorbis*" with miracidia of *Sch. hæmatobium*, which was chiefly met with in Bombay, failed for obvious reasons.

During this inquiry examination of local molluscs resulted in the discovery of seventeen different species of *cercaria* some of which bore the character of *Schistosome cercaria*. The author has succeeded in studying all stages of development of one of these and he has identified the adult stage as *Sch. spindalis*.

In conclusion he suggests a fresh survey of the Indian molluscs and further experimental work to settle the important question whether human Bilharziasis is likely to spread in India, a question which he thinks is still undecided.

Existence of distoma disease in India.—*By* N. F. Surveyor.

The author records a case of Paragonamiasis in a Chinaman who came to India and was admitted to the J. J. Hospital in Bombay suffering from pneumonia associated with hæmoptysis. He draws attention to the possible danger of imported cases of this disease which he considers to be greater since communication between India and China has increased within recent years.

The prophylaxis of dracontiasis.—*By* D. A. Turkhud.

Dracontiasis is a disease widely distributed over the Indian Peninsula; in some parts it is prevalent to an unusual degree. Figures collected from the jail populations show that the most afflicted area in the whole of India is the western portion of the Madras Presidency and Mysore; the Deccan proper follows these in intensity of the disease. In some of the districts dracontiasis is prevalent at times to such an extent as to seriously interfere with agricultural operations. Yet it is one of the most easily preventable of tropical diseases; but to be able to do this the life history of *Dracunculus medinensis* in man, the definite host of the worm and in the cyclops, the intermediary host, must be clearly understood. The disease can be prevented by breaking the chain anywhere in the developmental cycle of the worm. This can be done either by preventing human beings from infecting cyclops, or by preventing infected cyclops from gaining access to the human stomach. Mechanical filtration, chemical treatment and conversion of step-wells into draw-wells are measures which give no permanent protection and are therefore measures of temporary utility only. The only measure which will give permanent relief from the disease is to cover all wells which supply drinking water and to fit them with suitable pumps for lifting the water. Pumps are manufactured for use on shallow or deep wells, but unless the right kind of pump is fitted to a well it will not do its work properly. The conditions studied at a village called Desai in Thana district have shown that by adopting such a method for the prevention of this disease the inhabitants will not only be freed from the disease, but they will earn more wages and increase the prosperity of the village.

Note on a small outbreak of lobar pneumonia in Baghdad due to a bacillus of the Gaertner-Paratyphoid group. —*By* W. MacAdam.

(1) During the past few months a number of inagglutinable coliform organisms culturally and morphologically indistinguishable from B. para. B. have been isolated from blood cultures in Baghdad, and it is learned that similar findings have been recorded in a number of cases in other areas of Mesopotamia.

(2) During September, 1918, a series of 5 cases of fever occurred, from the blood of 4 of which this paratyphoid-like organism was isolated. Two of these patients, who were clinically cases of lobar pneumonia, died. At autopsy, the same coliform organism was isolated from the lungs and spleen and in one instance from the gall-bladder also. The lungs showed typical lesions of lobar pneumonia and in one case purulent softening was setting in. No lesion of any kind in the intestines was visible to the naked eye. No pneomococci were seen in smears or on culture from the lung juice. The other three cases of fever were associated with a certain amount of bronchial catarrh but there were no definite pulmonary lesions. All three cases recovered.

(3) An account is given of the morphological and cultural characters of the organisms which correspond to those of the Gaertner-Paratyphoid group. Serologically it was found to become agglutinable, after numer-

ous subculturings spread over 6 weeks, to specific Para. B. serum (titre—6,000) in dilutions as high as 2,500. The serum of one case of the infection taken during convalescence agglutinated not only his own organism but also all the other strains, in dilutions of 200-250, while the stock Para. B. emulsion was only slightly agglutinated in 1 in 50 dilution.—The question of the real identity of the organism is still undecided for the possibility of its belonging to the Suipestifer group has yet to be eliminated: mention is made of an epidemic among the Turks due to an organism which can be serologically differentiated from both B. para. B. and Bac Suipestifer.

(4) All 5 cases occurred within three weeks of each other, and, as far as could be ascertained, the infections were all contracted in Baghdad. It would be of considerable interest to know what proportion of the other inagglutinable coliform organisms with the cultural characters of B. para. B., which are being isolated from time to time in various areas of Mesopotamia, have the same characteristics, and are associated with the clinical signs of a septicæmia, or pulmonary affection, but the course of which does not at all suggest an "Enterica" infection.

Report on the anti-beri-beri vitamine content and anti-scorbutic property of sun-dried vegetables.—*By* J. A. Shorten and C. Roy.

Part 1.—Introduction :—The report deals with an investigation undertaken at the instance of Sir Leonard Rogers into the anti-beri-beri and anti-scorbutic properties of sun-dried vegetables from the Fruit Experiment Station, Quetta.

This part includes a description of the methods of preparation, etc. Of the vegetables under investigation as described in Bulletin No. 8 of the Fruit Experiment Station, dated March 1918, by Mrs. G. L. C. Howard, M.A., Second Imperial Economic Botanist.

Part 2.—Report on the anti-beri-beri Vitamine Content of four varieties of sun dried vegetables.

This part gives the results of feeding experiments on common fowls and shows that the addition of a moderate quantity of the dried vegetables to a basal diet of polished Rangoon Rice completely protects fowls from the onset of Polneuritis Gallinarum. The results are illustrated by photographs and microscopic slides.

Part 3.—Report on the anti-scorbutic property of sun-dried vegetables.

This part gives the results of feeding groups of guinea pigs on a basal scurvy-producing diet with the addition of sun-dried vegetables in the case of some of the groups. These experiments are not yet concluded, but it is hoped that they will yield definite results before the date of the Congress.

Appendix 1.—This is a reprint of the directions for cooking enclosed in each tin of sun-dried vegetables.

Appendix 2.—Chemical analyses of the varieties of vegetables experimented with.

There were two general discussions : the first on "Nitrogenous Fertilisers" was opened by Mr. J. MacKenna in the absence through illness of the author, and the second on "The Colloids and their Relation to Industry" opened by Mr. R. L. Mackenzie Wallis.

Nitrogenous fertilisers.—*By* C. M. Hutchinson.

The author, referring chiefly to the conditions prevailing in North-East India, pointed out that nitrogen is by no means always the limiting factor in many Indian soils and said that caution was necessary in the indiscriminate application of nitrogenous manures as under such treatment exhaustion of the mineral fertilising resources of the soil might easily result. Only a small portion of the nitrogen present in the soil is in a form immediately available for plant food, the proportion available depending on the rate at which the breaking down of protein matter and nitrification are taking place. The protein fermentation may easily take an undesirable direction leading to an accumulation of products not directly useful, while at the same time owing to the intensive cultivation the carbohydrate material in the soil is greatly diminished, with a resulting decrease in nitrogen assimilation. Hence if intensive methods of cultivation are to be maintained these losses must be made good by the addition of nitrogenous materials under carefully controlled conditions. The point is, can Indians afford these applications? This is an economic question which it is at present difficult to answer and involves such questions as the limiting of exports of oil seeds and the electrolytic production of nitrogenous compounds. These are questions which will soon have to be faced if the ultimate impoverishment of Indian soils is to be avoided.

Colloids and their relation to industry.—*By* R. L. MACKENZIE WALLIS.

After a general introduction the writer dealt particularly with the subject of protective colloids, instancing the use of dextrin, starch, etc., for the prevention of boiler scale, the use of gelatin in electro-plating to keep the metal in a finely divided amorphous condition. The application of colloid chemistry to foodstuffs had enabled the author to produce in India for a few annas a pound, a German food material formerly sold for export at nine shillings a pound. By the use of a protective colloid he had also been able to make an invalid food the digestibility and nutritive properties of which were high. The use of colloids in medicine, particularly in the reduction of toxicity of certain drugs, was touched upon. Details were given of the author's recent work on casein, e.g. the method of preparation of pure casein and its behaviour with various solvents, particularly pyridine. A glue powder, of great adhesiveness on moistening, prepared from lime and casein, was exhibited and the author anticipated that casein preparations would be used as a substitute for farina in sizing, for water-proofing canvas, for protecting stonework and preventing corrosion of metals.

The following Public Lectures were delivered :—

"The Life-History of a Star."—*By* DR. GILBERT T. WALKER, C.S.I., M.A., F.R.S.

"Waves in the Air and in the Aether."—*By* C. V. RAMAN, ESQ., M.A.

"Tactics against Insects."—*By* F. M. HOWLETT, ESQ., B.A., F.E.S.

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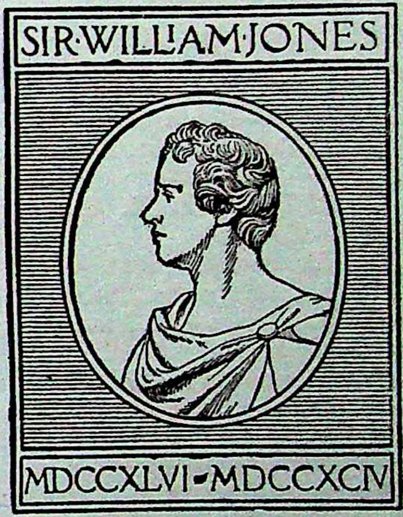
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12. Identification of Three Monuments at Sārnāth.

By BRINDAVAN C. BHATTACHARYA, M.A., M.R.A.S., A.R.S.G.S.

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its original foundations.

B. "A stone stupa" = the Jagat Singh Stūpa (according to Sir John Marshall).

C. "A stone pillar" = the Asoka Pillar.

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[1] Beal's Buddhist Record of the Western World (Popular Edition), Bk. VII, pp. 45-46. Also, Watter's "On Yuan Chwang's Travels," Vol. II, p. 50. Beal's Life of Hiuen-t-siang, p. 99. The height of the *Vihār*, as given here, is 100 ft. instead of 200 ft. as in other versions.

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12. Identification of Three Monuments at Sārnāth.

By Brindavan C. Bhattacharya, M.A., M.R.A.S., A.R.S.G.S.

Great diversity of opinion prevails among antiquarians with regard to three monuments discovered at Sarnath, *viz.* (1) The Asoka Pillar, (2) Jagat Sing stupa, and (3) the "Main Shrine." About these three we possess two ancient accounts of different ages One is Hiuen-t-siang's descriptions of Sārnāth, another is the account in Mahipala's Inscription. In Hiuen-t-siang's travels these monuments are mentioned as intact, whereas the Mahipala inscription makes mention only of repairs. No endeavour has hitherto been made to establish a correspondence between Hiuen-t-siang's account and that of the Mahipala's inscription or between these two and the topography of the newly discovered monuments.

Let us now examine the Chinese pilgrim's account in so far as it concerns our discussion. He writes :—To the northeast of the river Varanā about 10 li or so, we come to the Saṅghārāma of *Lu-ye*. Its precincts are divided into *eight portions* (sections) connected by a surrounding wall. In the great enclosure is a *Vihāra* about 200 ft. high ; above the roof is a golden-covered figure of the Āmra fruit. The foundations of the building are of stone, and the stairs also, but the towers and niches are of brick. In the middle of the *Vihāra* is a figure of Buddha made of (native copper) ; he is represented as turning the wheel of the law. To the south-west of the Vihara is a stone stupa built by Asoka-raja. Although the foundations have given way, there are still 100 ft. or more of the wall remaining. In front of the building is a stone pillar about 700 ft. high. The stone is altogether as bright as jade. It is glistening, and sparkles like light.[1]

Next let us examine how far the present remains can be identified with the monuments mentioned in the above extract ; we propose the following identifications :—

A. "A Vihara 200 ft. high" = the Main Shrine and its original foundations.
B. "A stone stupa" = the Jagat Singh Stūpa (according to Sir John Marshall).
C. "A stone pillar" = the Asoka Pillar.

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[1] Beal's Buddhist Record of the Western World (Popular Edition), Bk. VII, pp. 45-46. Also, Watter's "On Yuan Chwang's Travels," Vol. II, p. 50. Beal's Life of Hiuen-t-siang, p. 99. The height of the *Vihār*, as given here, is 100 ft. instead of 200 ft. as in other versions.

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Assuming these identifications to be correct, the actual progress of the pilgrim round the sacred precincts might have been somewhat as follows:—Entering the site where the "Main Shrine" now stands and where stood the old shrine facing the east and containing an image of the "Divine One," the pilgrim would retire keeping the shrine on his right hand *Pradakṣiṇena* and moving to the south; he would then come to the "Jagat Singh Stupa" and moving round. keeping it also to the right, he would finally look on the Asoka Pillar to the true north and to the west of the "Main Shrine."

Anybody examining the present main shrine carefully will come to the conclusion that its erection is of more recent date than the original. That the original site was a much larger one can be inferred from the pavement extending towards the east, which was undoubtedly the direction of its main gate.[1]

Sir John Marshall, upon close examination of the structure, has ascribed the Jagat Singh Stupa to the Asokan period.[2] This, therefore, was the stupa which the Chinese pilgrim noticed to the south-west of the main building.

The description left by Hiuen-t-siang of the pillar of "dazzling brightness" exactly fits in with the Asoka pillar now standing to the west of the Main Shrine. Sir John Marshall has questioned this identity, but nearly all his objections have been met by Dr. Vogel. We have, besides, Mr. V. A. Smith's remark in his "Asoka" which points to the same identity, "only two of the ten inscribed pillars known, namely, those at Rummindei and Sarnath, can be identified certainly with the monuments noticed by Hiuen-t-siang.[3]"

Turning to the Mahipala inscriptions, we note that many years after Hiuen-t-siang's visit to Sarnath, in 1026 A.D., an inscription was issued in Mahipal's reign to the effect that some repairs had been made to the ruins of Sārnāth.[4] Much light is thrown on the monuments under review by certain passages in this inscription.

The couplet we quote below is the most important part of the record:—

(*a*) "*Tau Dharmarājikāṃ Sāṁgaṃ Dharmacakra Punarṇavaṃ*"
(*b*) "*Kṛtavaṅtau ca avīnāmaṣṭa Mahāsthāna Śaila Gandha Kuṭīṃ*"

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[1] Hiuen-t-siang speaks of *Saṅghārāms* generally as having the "doors open towards the east." Beal's Record of the Western World (Popular Edition), p. 74.

[2] "Guide to the Buddhist Ruins of Sarnath" by Pt. D. R. Sahni, p. 9.

[3] Asoka (Second Edition), p. 124.

[4] Indian Antiquary, Vol. XIV, p. 139f: J.A.S.B. (N.S.), Vol. II, 1906, pp. 445-7, Epi. Ind., Vol. IX (1907-8), pp. 291-93.

Translation :—"they (Sthirapālā and Vasantapālā) repaired the Dharmarājikā and the Dharmacakra (vihara ?) including the accessories, as well as, the Gandhakuṭī, made of stone, belonging to eight great places."

We shall attempt, now, to examine these monuments and establish their identity, as far as we can, in the light of Ḥiuen-t-siang Travels, epigraphic finds and other documents.

DHARMARĀJIKĀ.—Dr. Vogel tried to identify the present "Dhāmekh Stupa" with the "Dharmarājikā" of the inscription. But since the publication of Dr. Venis' view that the word *Dhāmekh*' was derived from *Dharmekṣā* rather than from *Dharmarājikā*, Dr. Vogel abandoned his identification. Archæologists, have, however, ascertained that the *Dhāmekh* Stupa belongs to the Gupta period, and not to the Asokān period. The word *Dharmarājikā*, again, was used to denote Asokān stupas generally.[1] It has already been pointed out that the Jagat Singh Stupa was of Asokān age. We may infer, therefore, that the word " *Dharmarājikā* refers to the original structure of the Jagat Singh's Stupa. Moreover, we gather from the travels of Fahien that he saw a stupa where the *Pancavaggiyas* paid reverence to the Buddha, and to the north of it was the famous site of the "Turning the wheel of the law."[2] Judging from this, I am inclined to believe that the *Dharmarājikā* is the Jagat Singh stupa.

DHARMACAKRA.—It has been mentioned in the Mahīpāl lipi, as *Sāngam Dharmacakram*. Dr. Vogel took the word *sāṅgaṃ* to mean 'complete' and the late Dr. Venis seems to have accepted his interpretation. This rendering, in my opinion, is very doubtful. We meet with an expression like *Sāṅga Veda* meaning *Ṣaḍaṅga-Veda*. Likewise, we may take the expression *sāṅgaṃ Dharmacakraṃ* to mean the present *Dharmacakra* together with its various accessories. The meaning of Dharmacakra remains to be settled. From the fact that the Buddha at Sarnath turned 'the wheel of the Law' have originated in later times, the Dharmacakra symbol or the symbol of the wheel, the *Dharmacakramudrā* and even the name *Dharmacakravihār* denoting the monastery of Sarnath[3]; in a seal discovered in the course of excavation at Sarnath has been inscribed :—श्रीसद्धर्मचक्रे श्रीमूलगन्धकुट्यां भगवतो.[4] From this we may conclude that the whole monastery used to be called *Saddharmacakra* and a chapel within its precincts was known as *Mūlagandha Kuṭi*

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[1] 84,000 *Dharmarājikās* built by Asoka Dharmaraja, as stated by *Divyāvadāna* (Ed. Cowell and Neil, p. 379), quoted by Foucher Ico. Bouddhique, p. 554.

[2] The Pilgrimage of Fahien (translated by Laidlay), pp. 307-8.

[3] In the inscription of Kumāradevī, we find that Sarnath has been called *Saddharma-cakra vihār*; vide the present writer's "History of Ṣārnāth," p. 112.

[4] Hargreave's Annual Progress Report for 1915, p. 4.

(Main shrine). From this we may deduce that the present monastery, as a whole, together with its accessories has been meant by the expression *Sāṅgam Dharmacakram*. Again, Mr. A. K. Maitra, the founder of the Vārendra Research Society, is of opinion that the Dharmacakra Symbol, which formerly surmounted the lion capital of Asoka, and of which fragments are now preserved in the Sarnath Museum,[1] is the exact object which is denoted by the foregoing expression in the Mahipal Inscription. The practice of adorning the lion capital of Asoka with the Dharma cakkra symbol was not an uncommon feature in ancient days and we find the same thing on the Asoka pillar at Sāñchi. Therefore nothing can be said with certainty as to which object was exactly repaired—the whole monastery or the Asoka Pillar. It is not unlikely that the whole monastery was under repairs along with the repairs of the Dharmarājikā inasmuch as the monastery, the Gandha-Kūti and the Dharmarājikā were all in a ruinous condition. The Pala brothers, it may be supposed, undertook to repair all of them. It is also noteworthy in this connexion that no trace of repair can now be noticed on the surface of the Asoka Pillar.

AṢṬAMAHĀSTHĀNA-ŚAILA-GANDHAKUṬĪ — Dr. Hultsz, Dr. Vogel and Dr. Venis have offered various interpretations of this expression. Of these, Dr. Venis' is the latest. After having shown the impossibility of expounding the compound as the *Gandha Kuṭī* erected of stone, brought from eight great places, on the ground of Sanskrit grammar, he suggested the following interpretation: "Shrine is made of stone and in the shrine are or to it belong eight great places (positions)."[2] According to the rules of Sanskrit grammar, this compound can be no other than the मध्यमपद-लोपि समास. Then, of course, the component parts would be:—अष्टमहास्थानस्था (or स्थिता) शैलगन्धकुटी.[3] We shall consider now if this interpretation suits the topography of Sarnath and holds good on other grounds.[4] It appears to me that the word "*Śaila Gandhakuṭī*" here doubtless refers to the Main Shrine of to-day, for architectural characteristics of the 12th century A.D. are traceable in the ruins and the style of this building. The word Gandhakuti has been discussed elsewhere.[5] Again, the previously mentioned earthen Seal, bearing the legend श्रीसद्धर्म्मचक्रे मूलगन्धकुट्यां भगवतो, furnishes us with the information that "in the Mūla Gandhakuti which was situated in the Saddharmacakra Vihāra." etc. The age of this epigraph is much anterior to that of the Mahipal inscription. Round the chapel in which the Buddha dwelt an extensive monastery may have gradually come into being. That chapel used to be called "Gandhakuti" and the whole monastery passed by many different names. Our attention may be turned again to Hiuen-t-siang's account for the sake of comparison. We find there that he also saw the whole monastery and a high building made of stone.[1] There was an image of Buddha therein, represented in the *Dharma cakra mudrā*. In the traveller's account, one thing appears to be specially striking, and on this he seems to lay much stress: "The *Saṅghārāma* was divided into eight portions (Sections)."[2] I conjecture from this that these eight parts of the *Saṅghārāma* developed in course of time into eight great places or monasteries which constituted the whole establishment. And very probably this *Saṅghārāma* having distinct divisions received the true designation of *Aṣṭa mahāsthāna*. It may be noted that six distinct monasteries have already been exhumed by modern exploration. I have also been informed by a Superintendent of the Indian Archæological Department that probable sites of more vihāras still lie hidden on the east of the सङ्घाराम. No excavation has been carried on in that direction. We may, nevertheless, arrive at these conclusions, that *Aṣṭamahāsthān* was the name given to the whole Sanghārāma and *Śaila gandhakuti* was the name which signified an old stone building situated probably in the middle of the *Sanghārāma* and therefore called at one time Mūla, meaning "central" or "original," from the fact that the Buddha set up his first residence there, and at another time *Śaila*, as it was chiefly built of stone.

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[1] Sir John Marshall's Annual Report, A.S., 1904-5, p. 36.

[2] J.A.S.B., N.S., Vol. II, No. 9, p. 447.

[3] Cf. वियन्मध्यहंस Daśakumāra Carita.

[4] Mr. Hargreaves, the Superintendent, Archæological Survey, in a letter to me expressed the view—"Its explanation, I am afraid, must always remain doubtful."

[5] Buddhist literature informs us that the room where the Buddha dwelt was usually made fragrant by burning incense and thus it received the name of Gandha Kuti. The word, in course of time, has been modified into Gandholā and came to be used in a similar sense in Tibetan books—"Pag-Sam-Jon-Zang" by S. C. Das, p. 77.

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[1] Op. cit.

[2] Cf. Watter's version—"This establishment, he says, was *in eight divisions* all enclosed within one wall"—Watters, Vol. II, p. 50.

13. The Territorial System of the Rajput Kingdoms of Mediaeval Chhattisgarh.

By C. U. Wills, I.C.S.

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CHAPTER I.

Introduction.

1. Chhattisgarh, a great inland basin drained by the Upper Mahanadi and its tributaries, is the easternmost Division of the Central Provinces. It possesses a marked individuality. In their speech, their dress and their manners the inhabitants of the country have many peculiarities of their own. There is more homogeneity among them than is to be found in other parts of the Province. And their political history also has developed on independent lines—a circumstance which in itself should excuse an attempt, however incomplete, to throw light on the dark ages which preceded the Maratha conquest.

As a Settlement Officer my attention was first drawn some years ago to the curious mediaeval land-system of this tract of country. And I venture now, as the result of subsequent investigations, to put in writing the following account of the old Rajput kingdoms of Ratanpur and Raipur.

2. The little that is definitely known regarding the Haihaibansi dynasty in Chhattisgarh may be summarized as follows:—

In the 10th century A.D. a powerful Rajput family ruled at Tripuri or Tewar near Jubbulpore. Issuing from this kingdom of Chedi a scion of the royal house, by name Kalingaraja, settled, about the year 1000 A.D. at Tuman, a site at present marked only by a few ruins in the north-east of the Lapha Zamindari of the Bilaspur District. His grandson, Ratnaraja, founded Ratanpur which continued the capital of a large part of the country now known as Chhattisgarh until it passed into the hands of the British. Of the varying fortunes of this royal house we know little or nothing; and we search in vain in the writings of Indian historians for any reference to this extensive territory. All we can affirm is that the dynasty continued in vigorous life for some six centuries; that about the 14th century it split into two portions, the elder branch continuing at Ratanpur while the younger ruled in semi-independent state at Raipur[1]; that about the end of the 16th century it acknowledged the suzereinty of the Great Mogul; and that thereafter it sank into complete obscurity but was never dispossessed until the Marathas, after conquering the country, deposed Raghunathsingh, the last survivor of the Ratanpur house, in 1745 A.D., and 10 years later removed Amarsingh also, his kinsman on the Raipur throne.

3. One would at first, suppose it an easy task to recover the main outline of the Rajput régime in Chhattisgarh, lasting, as it did without interruption so far as we can learn, for over 700 years. But memories are nowhere shorter than in the "Immemorial East." Few Europeans have been interested in this obscure corner of the Empire, in spite of the fact that it presents the remarkable picture of a Hindu Government continuing till modern times outside the sphere of direct Mohammedan control; and, when we try to discover the social or political organization of the country prior to 1745 A.D., we find ourselves groping almost in complete darkness.

That any relics of the old order of things survived long enough to be observed and recorded by the first British officials who visited the country must be attributed to the extraordinary isolation of Chhattisgarh. It was in pre-British days a territory "surrounded on all sides by almost uninhabited "jungles varying in breadth from about 50 to more than 200 "miles and during the rains perfectly inaccessible from the "want of good roads." (Hewitt's Report of 1869, paragraph 31). In this land-locked seclusion curious institutions, survivals of an earlier society, found it possible to persist in a recognizable if mutilated form.

The fullest account of Chhattisgarh history which has been published is to be found in Vol. XVII of the Archaeological Survey of India This was written some 36 years ago by Sir Alexander Cunningham. It covers 20 pages, and gives as complete information as could at that time be obtained from inscriptional and other written sources. But it deals primarily with names and dates and places, and throws no light on the internal organization of the country.

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[1] See paragraph 10 below.

4. My enquiries as regards the old territorial divisions of Chhattisgarh disclose the following symmetrical arrangement:—

(*a*) The whole country was divided into two kingdoms—a northern kingdom with its capital at Ratanpur and a southern with its capital at Raipur.

(*b*) Each kingdom or *Raj* was subdivided into districts known as *Garhs* or Forts, conventionally supposed to be eighteen in number. The whole owed allegiance to a Rajput king.

(*c*) Each district or *Garh* was conventionally supposed to contain 84 villages, whence the term *Chaurasi* is derived. It was held by a *Diwan* or *Thakur*, a local chief whose powers within his territory were of the widest kind.

(*d*) Inside the *Garh* were smaller units or *Taluqs*, each conventionally supposed to contain 12 villages and therefore known as *Barhons*. These were held by *Daos* or *Barhainihas*, minor chiefs, whose authority within their *Taluq* closely resembled that of the *Diwan* within the *Garh*.

The *Dao* was ordinarily the Headman or *Gaontia* of the village where he resided, the other villages of his *Taluq* being held by separate *Gaontias* who acknowledged his authority. Similarly the *Diwan* was the *Dao* of the particular *Taluq* in which his headquarters were situated, while his other *Taluqs* were allotted to chiefs of the second degree subordinate to him. Lastly the *Raja* kept under his direct control the Headquarter *Garh*, while the other *Garhs* of his kingdom were allotted to chiefs of the higher rank. Sometimes the chiefs of *Garhs* were kinsmen of the *Raja*; the minor chiefs of *Taluqs* were similarly related in some cases to the lord of the *Garh*, and the *Gaontias* in their degree were sometimes related to the chief of their *Taluq*.

5. In setting forth in detail the evidence which establishes the former existence of this organization, I do not mean to assert that it was at any one time exemplified in full detail everywhere in Chhattisgarh. It was no more than the "theory," as one authority[1] describes it, on which the system worked; for "it is well known to all who have enquired into Indian "institutions that they are directed by a general understand-"ing, seldom if ever by precise rules; and that that under-"standing is so loosely acted upon that, amongst the innumer-"able deviations that are met with, it is no easy task to dis-"cover the most universal and established practice."[2]

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[1] Lieutenant Macpherson's Report of 1842 on the Khonds, Part II, Section I, paragraph 12.

[2] Major Van Agnew's Report of 1820 on Chhattisgarh.

CHAPTER II.

THE RAJ OR ATHARAHGARH.

6. The fact that the name Chhattisgarh (36 Forts) is derived from the existence of two adjacent kingdoms of *Atharahgarh* (18 Forts) is, one would have thought, indisputable. Writing more than a century ago the author of "A Narrative of a Journey from Mirzapur to Nagpur in 1798-9" tells us that "Chhuri is one of the thirty-six towns and forts which give name to the province of Chhattisgarh." But there is, in Vol. VIII of the Archaeological Survey of India (page 224), an article, the writer of which rejects the "legend" deriving the term *Chhattisgarh* from 36 forts as "a modern invention to account for the name," and substitutes a theory that the correct name of this part of the country is *Chhattisghar* (36 houses) derived from the immigration of 36 families of Chamars from Behar. This theory, evolved by Mr. Beglar at his first visit to Ratanpur and Raipur, would not need to be seriously considered, were it not that his contention gains a weight which it does not deserve by reason of its publication in the official records of the Archaeological Department.

Thus Mr. P. N. Bose begins his "Notes on the tribes, sects and castes of Chhattisgarh" (published at page 269 of the Journal of the Asiatic Society of Bengal, Vol. LIX, Part I, for 1890) as follows :—

"The Bengal-Nagpur Railway will open up a tract of "country which is now but little known to the public. In the "Central Provinces, it is called Chhattisgarh. Two deriva-"tions of the name have been proposed. According to the "Central Provinces Gazetteer Chhattisgarh owes its name to "thirty-six (*Chhattis*) forts (*garh*) included within it. Serious "objections, however, have been urged against this interpreta-"tion by Mr. Beglar of the Archaeological Survey. While in "Behar he heard a tradition, that ages ago, in the time of "Jarasandha, thirty-six families of Chamars had emigrated "from that country and settled in a country far to the south "of it, which was called *Chhattisghar* (thirty-six families). He "was not at the time aware of any country which bore that "name, and his enquiries with regard to it being ineffectual, he "became rather sceptical about its existence. When, however, "official duty brought him to Chhattisgarh the tradition he "had heard in Behar, came back to his mind. Here was a "country far from Behar, and south of it, the people of which "appeared to him to be singularly like the Beharis in their "language, dress, manners and customs—a people, too, of which "the Chamars formed a very important element. Mr. Beglar "suggests that Chhattisgarh derives its name from the thirty-"six families of Behari Chamars who settled there; according

> to which interpretation Chhattisgarh should be spelt Chhattisghar. Considering that long intercourse had made Mr. Beglar perfectly familiar with the Beharis before he visited Chhattisgarh his interpretation becomes authoritative. Besides, it promises to throw some light on the history and affinities of one of the most remarkable peoples that inhabit India—the Chhattisgarhi Chamars. We must say, however, that as the word is pronounced by the people, it is difficult to make out whether Chhattisghar or Chhattisgarh is the correct spelling; we have adopted the latter as the one in current use.”

So far from being authoritative I fear that Mr. Beglar's interpretation cannot stand a moment's investigation To begin with *garh* is, to the native ear, as distinct from *ghar* as to the Englishman “shave” is from “safe”; and if further argument is needed I trust the following pages will provide it.

7. There are several lists extant of the *Chhattis Garh.* Some are preserved in Ratanpur. The following is the one given in para. 48 of Mr. Chisholm's Settlement Report on the Bilaspur District, published in 1869, and reproduced in the old Gazetteer of the Central Provinces.

	Name of Fort.	Number of Villages.		Name of Fort.	Number of Villages.
1	Ratanpur	360	1	Raipur	640
2	Maro	354	2	Patan	152
3	Bijaipur	326	3	Simga	84
4	Kharod	145	4	Singarpur	(not known)
5	Kotgarh	84	5	Lawan (84 × 3)	252
6	Nawagarh	84	6	Amera	84
7	Sonthi	84	7	Drug	84
8	Okhar	32	8	Sarda	(not known)
9	Pandarbhatta (including Mungeli)	324	9	Sirsa	84
10	Semaria	84	10	Mohdi	84
11	Champa	153	11	Khalari	84
12	Lapha	200	12	Sirpur	84
13	Chhuri	220	13	Phingeshwar	84
14	Kenda	84	14	Rajim	84
15	Matin	84	15	Singangarh	84
16	Uprora	84	16	Suarmar	84
17	Pendra	84	17	Tengnagarh	84
18	Kurkuttie (2 garhs)	700	18	Akalwara	84

The number of villages is not given in Mr. Chisholm's report. The numbers in the first column above are taken from page 40 of the Bilaspur District Gazetteer. Those in the second column are taken from page 18 of Mr. Hewitt's Settlement Report of 1869 on the Raipur District. (See para. 69 below).

8. One feature is common to all these lists of *Garhs.* They are invariably divided into two equal portions, eighteen

forts in the tract north of the Sheonath river being entered under Ratanpur, and eighteen in the tract south of the Sheonath river under Raipur. This alone suggests that the term *Atharah Garh* had a special significance; and when we find that the adjoining kingdom of Sambalpur,[1] now a district of Behar and Orissa, was known by this very name the suggestion rises almost to a certainty. In a very remarkable report written by a certain Mr. Motte who visited Sambalpur in search of diamonds in 1766 A.D. we read that " The Sambalpur Pro-" vince is so called from its capital; but the Rajah takes the " title of Rajah of eighteen forts. Such titles are common " among the Hindus, and I doubt if the capital of the Maha-" rattas which we call Sattarah-gur or the Star fort is not " Sattarah-gur or the seventeen forts, for Sattarah is not a star " in any of the Hindu languages. There are two Rajas of " thirty-six forts—one in the Allahabad Province, the other to " the northward of Lucknow."

9. This evidence will probably satisfy most people that the term *Atharah Garh* was, in this part of India, a conventional expression indicating the existence of a *Raj* or kingdom; and that our *Chhattisgarh* (of which, oddly enough, Mr. Motte makes no mention) was so called from the existence within it of two allied states. But we have other indications leading to the same conclusion.

10. In an old Ratanpur inscription of 1114 A.D. (No. 140 in the Descriptive List of Central Provinces Inscriptions) we read that Kokalla, a ruler of the Chedi kingdom from which the Rajput kings of Ratanpur and Raipur were descended, " had 18 sons, of whom the first-born was ruler of Tripuri (the capital of Chedi, near Jubbulpore, as already stated) " while the others became Lords of *Mandalas* (Districts)." The statement is not absolutely explicit; but it needs no stretch of imagination to suppose that ancient Chedi was itself divided into 18 districts, and that a similar organization was also adopted, or assumed to exist, in the country further south round Ratanpur when it was conquered by off-shoots of the Chedi house.

The earliest direct reference to *Atharah Garh* is found in a Raipur Inscription of 1415 A.D. (No. 125 in Rai Bahadur Hiralal's " Descriptive list ") where we are told that Simhanadeva, King of Raipur, conquered " 18 forts or strongholds of adversaries." This may well have been the occasion of the establishment of the separate appanage of Raipur,[2] for in the Bastar State we find the same thing happening. " In 1502 A.D.

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[1] The Sambalpur Atharahgarh is dealt with at length in Chapter VI.

[2] The view here suggested that the Kingdom of Raipur was an " appanage " of the Ratanpur Raj seems to be most consistent with what we know of the relations between the two. Raipur was certainly

"Pratap Rajdeo came to the throne. He conquered 18 forts "round Dongar and assigned them to his younger brother as "an appanage." (Sils' History of the Central Provinces and Berar, page 115). In this case history repeated itself for in Col. Elliot's report of 1856 we again read that the Rajah of Bastar Rajah Bhyro Deo invested his younger brother Dalganjan Singh with "18 *Garhs* as an appanage for his livelihood."

11. Lastly, I would note the curious fact that the Feudatory State of Kalahandi is still sub-divided into 18 *garhs.* My attention was first drawn to this Dependency by the remark of Sir R. Jenkins, on page 213 of his report on the Nagpur territorries written in 1826, that Kharonde or Kalahandi is "divided into eighteen *garhs* or petty zamindaries." I then turned to the report on this state contained in No. XXX of the "Selections from the Records of the Government of India (Foreign Department)" written by Lieut.-Col. Elliott in 1856. There I found it stated that Kalahandi "originally consisted "of 14 *garhs* to which four were subsequently added in the "year 1122 Fasli (or 1712 A.D.) having been ceded by the Raja "of Jaipur." This, at first sight, seemed fatal to any attempt to attach significance to the figure eighteen. But a further examination of the report made it clear that, in reality, the state had always contained 18 *Garhs*, but that five had been compressed into one, presumably at the time of the cession of four additional *Garhs* from Jeypore, with a view to preventing any disturbance of the conventional *Atharah Garh.*

12. I give below an abstract of the distribution of *Garhs* in Kalahandi noted in the report of 1856.

KHALSA, 5 GARHS.

(i) Junagarh with 12 sub-divisions and 326 villages.
(ii) Bhundesir with 16 sub-divisions and 187 villages.
(iii) Asoorgarh with one sub-division and 85 villages.
(iv) Dohgaon with one sub-division and 43 villages.
(v) Kooksurah with one sub-division and 57 villages.

JHOOAMOOL ESTATE, 7 GARHS.

(vi) Jhooamool with 15 sub-divisions and 126 villages.
(vii) Deypore with 4 sub-divisions and 55 villages.

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held by a younger branch of the Ratanpur family and according to Hewitt (Report of 1869, para 54) "the rulers of Raipore were entirely "subordinate to the Head of the family at Ratanpur." And Agnew (Report of 1820, p. 2) writes: "Members of the Ratanpur family seem "to have been occasionally deputed to rule at Raipur, Lawan and in "other parts of the province; but, as far as I can ascertain, they were "never wholly independent of the Ruttunpore Government. Thus "Jagannath Sai before his accession to the gaddi of Ratanpur was "Governor of Lawan and his grandson Bariar Singh subsequently became "Raja of Raipur."

(viii) Mandabissi with 3 sub-divisions and 39 villages.
(ix) Kassipore with 2 sub-divisions and 128 villages.
(x) Mohalpatna with 8 sub-divisions and 107 villages.
(xi) Chandragiri with 2 sub-divisions and 21 villages.
(xii) Bisamgiri with 2 sub-divisions and 23 villages.

DADPORE ESTATE, 1 GARH.

(xiii) Dadpore with 8 sub-divisions and 109 villages.

LANJIGARH ESTATE, 3 GARHS.

(xiv) Lanjigarh with 5 sub-divisions and 89 villages.
(xv) Moonda with 1 sub-division and 16 villages.
(xvi) Bhoortee with 1 sub-division and 34 villages.

KORLAPAT ESTATE, 1 GARH.

(xvii) Korlapat with 11 sub-divisions and 103 villages.

MADANPUR ESTATE, 1 GARH.

(xviii) Madanpur with 5 *Taluqs*.
  (*a*) Madanpur with 5 sub-divisions and 75 villages.
  (*b*) Mohangiri with 2 sub-divisions and 24 villages.
  (*c*) Japrang with 4 sub-divisions and 38 villages.
  (*d*) Oorladoni with 3 sub-divisions and 38 villages.
  (*e*) Burka with 1 sub-division and 29 villages.

It requires no great perspicacity to see that the so-called *Taluqs* of the Madanpur *Garh*, each regularly subdivided, are in reality *Garhs* which have been re-christened *Taluqs*. The *Taluq*, as an area intermediate between the *Garh* and the "Sub-division," has no parallel in the rest of the dependency. And the obvious explanation of the anomaly is that Kalahandi originally contained not 14 but 18 *Garhs*, and when four others were ceded from Jeypore the five *Garhs* in the Madanpur Estate were telescoped into one and called *Taluqs*, simply in order to retain the conventional division of the Dependency into *Atharah Garh*.

13. Kalahandi is the main link in the chain of evidence which proves the tribal origin of the land system of Chhattisgarh[1] and I shall have to refer again more than once to this Dependency. Here I have only one point to emphasize. There is an obvious and striking parallel between its territorial organization in 1856 and that which I have set myself to prove to have been formerly ubiquitous in Chhattisgarh. The division of the country into 18 *Garhs*, and of each *Garh* into *Taluqs*

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[1] See Chapter VII.

containing about a dozen villages a piece, is shown in complete detail. There is also in a letter (No. 172, dated the 13th July 1862, from Captain Glasfurd, Deputy Commissioner of the Godavery Taluqs, to the Chief Commissioner of the Central Provinces, which I obtained from the Sambalpur District office) a specific reference to a class of persons in Kalahandi described as "*Paters* or hereditary heads of *Garhs*" while the latest Gazetteer (1910) refers to the former existence of *Umrahs* or Khond Chieftains holding on tenures intermediate between the Raja and the people. These are all indications that a system formerly existed in Kalahandi closely resembling that which I have sketched for Chhattisgarh in para. 4 above.

CHAPTER III.

THE GARH OR CHAURASI.

14. It would be flogging a dead horse to elaborate at length the evidence in support of the existence of *Chaurasis* or tracts of 84 villages. Yet reference to "84 village tracts" is constantly found in official reports, evidently without the writer realizing how purely conventional this number is. In the absence of any other collective reference either to the existence of *Chaurasis* in Chhattisgarh and the adjacent countries, or to their identity with the *Garh* a brief summary of the evidence on these points may be given.

15. The *locus classicus* as regards the *Chaurasi* or District of 84 villages is the notice at page 47, Vol. II of Beame's Memoirs of the North-West Provinces—an amplification of Sir H. Elliott's Glossary of Indian terms. This very full account will be referred to more than once in the following pages. Here I would mention it chiefly in order to carry conviction to the minds of those who may at first be tempted to regard the term *Chaurasi* as fictitious. To those to whom this use of a number in relation to a territorial unit is unfamiliar I cannot do better than recommend a careful perusal of the article in the Glossary above-mentioned. Nearly a hundred instances of *Chaurasis* are there collected and the author claims to have established their existence "in almost every district" of the old North-Western Provinces. He quotes instances from the Central Provinces, e.g. "Parganah Jhillo in Saugor" he says, "is a Chaurasi......Garha Kota in Damoh of Saugor "(sic) is a Bundela Chaurasi....The Parganah of Tezgarh in "Damoh is a Chaurasi and the Bunaphar Rajputs have a "Chaurasi in Garha Mandla......There is a Chaurasi of "Dhakara Rajputs in Fattehpur of Hoshangabad, and in "Sobhapur of the same District there is one of Gujars," and so on.

But with two exceptions, the instances quoted by Sir H. Elliott are not taken from any of the old kingdoms in or around Chhattisgarh. The following may therefore serve as, in some measure, a supplement to the list given in the Glossary.

16. Among the "36 forts" given in para. 7 above, it will be noticed that no fewer than 21 are groups of 84 villages. On page 117 of the Bilaspur Gazetteer there is reference to a *Chaurasi* at Loharsi held by a Brahmin family.

In Major Roughsedge's Report of 1818 on the State of Sarguja and its dependencies, five *Chaurasis* are mentioned. In Appendix B of Sir R. Temple's Report on the Zamindaris of the Central Provinces dated 31/10/1863 Sahaspur and Suarmar Zamindaris are said each to contain 84 villages, and reference is also made to 84 villages, being taken from Phuljhar and included in the Borasambar Estate.

In Vol. XVII of Sir W. Hunter's Statistical Account of Bengal two *Chaurasis* are mentioned as existing in the Korea State (op. cit., p. 216) and one in the Gangpur State (op. cit., p. 193). In a printed report on the Mandla District by Captain Pearson written in 1860 two *Chaurasis* are mentioned on pages 29 and 30.

In the Chhattisgarh Feudatory States Gazetteer, published in 1909, where one might have looked for more frequent notice of these territorial divisions, I can find but a single *Chaurasi* noted as having existed formerly in the Sarangarh State (vide Gazetteer, p. 205).

Appendix D of the Rewah State Gazetteer published in 1907 contains a "Statement of villages by Parganas in the time of Maharaja Ajit Singh (1761 A.D.)" in which nine parganas of 84 villages are mentioned, and a marginal note records that "*Chaurasi* was the most common convention of naming Parganas."

Rewa, Sarguja, Mandla, Korea, Gangpur and Sarangarh are all territories adjacent to Ratanpur and Raipur. The use of this conventional figure as a territorial unit was therefore widely prevalent and, as I have shown, was particularly well known in Chhattisgarh.

17. As to the identity of the *Garh* and the *Chaurasi* there is little difficulty in proving this. Both are synonyms for *Parganah*, and are therefore themselves interchangeable terms. For instance, the present Zamindari of Matin was one of the 18 *Garhs* subordinate to Ratanpur. It is still known as one of the *Satgarh* of the Bilaspur District. Blunt in 1795 calls it the *Khas Parganah* of Matin and describes it as one of "seven small Districts called *Chaurasis*"—evidently referring to what are more commonly known as the *Satgarh*. In 1864 Matin was still described as a "*Parganah*." We may take an even more striking instance. In Mr. Hewitt's Settlement Report (page 18) he quotes from an old account of the Haihaibansi

Kingdom[1] a list of 16 "Khalsa *Parganahs*." Of these 13 are shown in the list as *Chaurasis* containing 84 villages, while every one of the 16 appears in the accepted lists of *Garhs* subordinate to Raipur. Elliott, it is true, begins his article on *Chaurasis* by saying that "the word means literally 84: and "is territorially applied to a sub-division of a parganah or district amounting to 84 villages." But this definition is not borne out by his own list which records many *Chaurasis* comprising whole *Parganahs*, while it is, for Chhattisgarh, refuted by the remark in the Rewa List, quoted in the preceding paragraph that "*Chaurasi* was the most common convention of naming *Parganahs*."

18. In Chhattisgarh at the head of each *Garh* or *Chaurasi* other than those (perhaps one or two) which the Raja himself administered, stood the local Chief known as *Dèwan* or *Thakur.* These petty chieftains, some of whom were related to the Raja, formed the local aristocracy, and were practically independent in regard to the internal administration of their estates, though bound to give service and supplies to their lord paramount. "The Haihaibansis merely stood at the head of a number of "petty Rajahs and Chiefs each of whom was to a large extent in"dependent, and among whom the whole country was divided" (Chisholm's Report of 1869, para. 64). "Under the Haihai"bansi Rajahs the feudal principles of their rule precluded "anything in the nature of a system of revenue. The Rajahs "and the members of his family retained no more lands under "their own management than was necessary for their comfort "and dignity. *The rest were assigned to their chiefs* who, on "their requisition, supplied them with whatever they required, "with money according to their wants and in war with quotas "of troops proportioned to the lands they held. These petty "lords seem, on their part, to have followed the same system, "retaining but small tracts of land in their own hands and "distributing the remainder among their servants who were at "the same time soldiers and cultivators. The judicial autho"rity in important cases they personally exercised, but in all "inferior and common occasions they left the chief executive "authority in revenue as well as other matters to the head of "each *Talooq* or village who it may be concluded did not act "upon any general or uniform plan. The conquest of the "country by the Mahrattas changed this state of things." (Agnew's Report of 1820, p. 10).

As some indication of the power which these local chiefs wielded within the limits of their own estates it may be observed that those of them in the hilly country who survived the Maratha rule so disastrous to indigenous institutions were still found in possession of powers of life and death within their own territories in 1821. Thus the engagement entered into by the Zamindars of Chhattisgarh in that year (see No. CLXVI in Vol. I, Part IV of Aitcheson's Treaties) recites that the Zamindar will levy no customs, offer no interruption to travellers or merchants, not punish any person with death without the previous sanction of the Sircar, and not make war upon any Zamindar or other person without the orders of the Sircar. These chieftains held in fact a position closely analogous to that of the Heads of the 48 Zamindaris into which the Bastar State was formerly divided, each of whom, as reported by Major Vans Agnew in 1821 (see para. 65 below), "pay a rent long since established and which does not vary, "and exercise an almost unlimited authority within their respective Zamindaris but are subject to the Rajah in all that "refers to the general interests of the State."

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[1] See para. 69 below.

CHAPTER IV.

THE TALUQ OR BARHON.

19. We now come to the more obscure, but none the less interesting, subdivision known in Chhattisgarh as the *Taluq* or *Barhon* (from *Barah* meaning 12), owing to the fact that it was conventionally supposed to comprise an area of 12 villages. The chief authority for this old territorial grouping in Chhattisgarh is the reference, in paras. 59 to 63, 74, 75, 145 and 239 of Mr. Hewitt's Raipur Settlement Report of 1869, to what he calls "the *Talooqdaree* System." He writes: "Under the "Haihaibansi dynasty the Government seems to have been a "patriarchal aristocracy, *the system being derived from the Gonds*. "Under the nomad invaders of the Turanian race the unit "seems not to have been the family but the clan. Hence, "while in Upper India the family developed into the village "community, among the Turanian races the clans settled "themselves in a number of neighbouring villages which were "formed into a *Talooqua*. All the original inhabitants of each "of the *Talooquas* were attached to their chief by the ties of "blood or community of interest (para. 59)....... In succeeding generations the old system was almost obliterated, "and not only were the older holders ejected from their *Talooquas*, but the boundaries of *Talooquas* were disregarded and "two or three or even single villages were given to applicants, "while the Gond ryots were swamped by foreign settlers (para. "62)........ Though the vitality of the land system of "Chhattisgarh had been almost annihilated....... owing to "the causes stated, yet the old *Talooquas* were numerous in "1818 as the following remarks, quoted from a report c

“Colonel Agnew's to the Resident, will show[1]....... ‘The “ ‘*Gaontias* here are the heads of the villages in which they “ ‘reside, and cannot hold office in more than one village; they “ ‘are almost invariably inhabitants of the country. The *Patels* “ ‘on the contrary have authority over a *Talooq* or several “ ‘villages and are frequently strangers who have obtained the “ ‘situation from interest....... Against the *Gaontias* I have “ ‘very seldom met with complaints from the ryots, but against “ ‘the latter they are frequent. In consequence of these com- “ ‘plaints the *Patels*, called in Chuteesgurh *Daos*, were set aside “ ‘whenever possible’........... But, though the *Talooq-* “ *dars* were removed, yet the names and limits of their estates “ are still in many cases well known to the people, more es- “ pecially in the jungles where there has been less change..... “ In some instances the *Talooqas* were found at the Settlement “ [of 1869] in the hands of men who had held them from the “ time of the Haihaibansi Rajas.”

20. This account by Mr. Hewitt is the only description of the *Taluqdari* system in Chhattisgarh which we possess, and his appreciation of the scanty survivals which existed in his time is to be attributed to the fact that he was interested in early tribal institutions. He continued his studies in this direction when Commissioner of Chota Nagpur, and was able to establish the identity of the “*Taluqdari* system” of Chhattisgarh with the “*Patti* system” further east. In a paper on “Village Communities in India” published in Vol. XXXV of the Journal of the Society of Arts for May 6th, 1887, Mr. Hewitt specifically refers to the existence in the Central Provinces (meaning of course Chhattisgarh) of the “*Parha* or tribal territory, known locally as the *Talooqua*,” and treats it as analogous to the tribal grouping of the Hos and Mundas.

The similarity of this *Patti* system of Chota Nagpur to the *Taluqdari* system described by Mr. Hewitt in Chhattisgarh is apparent from the following extract (p. 119 *et seq*) from a book called “The Mundas and their Country” by Mr. S. C. Roy.

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[1] On page 32 of Colonel (then Major) Agnew's Report of 1820 on Chhattisgarh we read: “The situation of Patel is not of ancient origin. It “was established by the Mahrattas soon after their conquest of the “country as a means, there is every reason to suppose, of providing for “the needy Brahmans of their own tribe. They are the superiors of “several villages or of a *Taluq*, having *Gaontias* at those villages where “they do not themselves reside....... The situation of Gaontias is of “ancient standing and existed in the time of the Haihaibansi Rajahs.” So far as this passage leads one to infer that the organization of the country into *Taluqs* under the superintendence of an individual headman was introduced by the Marathas it is entirely incorrect. That this is so is clearly shown by the traditions of the people, by the evidence we possess in the present Zamindari estates, and also by the passage in paragraphs 74 and 75 of Mr. Hewitt's Settlement Report of 1869 above quoted.

"Over and above the village organization the Mundas in "course of time came to have a tribal organization of their "own. Motives similar to those which prompted them to hold "together in villages would appear to have led them gradually "to organize larger unions made up of groups of villages. As "time went on the Munda saw the necessity of making himself "stronger, so as to be able to effectually protect his brother-"hood against the aggressions of other village units that were "growing apace all round, and this led to the wider organiza-"tion known as the *Patti system*. The villages by batches "usually of 12—but sometimes more and sometimes less—"came to be grouped together as a *patti*, with the strongest "and most influential among the headmen of these villages as "the *Manki* or *Patti* Chief. The remaining village headmen "swore allegiance to the elected *Manki*. Military Service was "the primary, and in the beginning perhaps the sole con-"dition. But in course of time it was thought proper to "symbolize the relationship. Each village headman of the "*Patti* would make periodical presents to the *Manki*........ "But in course of time, the origin of the periodical presents "was lost sight of and what began as free gifts came to be "regarded as rightful dues. But all the same the *Manki* like "the *Munda* (Village Headman) was always looked upon as "a chief among equals—a leader and not a ruler. Nor did "any superior rights or property appertain to the Mankiship. "As under most oriental institutions the offices of the *Manki* "as well as of the *Munda* gradually became hereditary. In "the internal administration of each village the *Munda* was "assisted by the village *panch* or Council of village elders. "The tribunal thus constituted arbitrated in all disputes amongst "villagers *inter se*. Custom was the recognised law......In "disputes between village and village and in cases of unusual "importance or tribal interest the *Patti* Punch presided over "by the *Manki* was called upon to adjudicate. And even now "the village *punch* and the *Parha Panch* or *Patti* panch play "important parts in Munda village polity."

21. Looking to the statements I have quoted, it is natural for us to suppose that the ancient *Taluqdari* system of Chhattisgarh as described by Mr. Hewitt, corresponding as it did to the *Parha* or *Patti* system among the Mundas of Chota Nagpur, originally involved the existence of a net-work of small groups of about 12 villages each, spread over the whole country. And this view receives immediate confirmation from evidence still available in the *Zamindari* Estates which lie together in Northern Chhattisgarh. This peculiar tract, known locally as the *Satgarh*, was left practically untouched by the Mahrattas, and obvious traces of a *Taluqdari* system were still visible there when British rule began. As the best instance of all, I may quote the following extract from para. 4 of a Report of

1860 now in the Raipur District office on the Pendra Estate reckoned the chief of the *Sat Garh*, and entered in every list of the Ratanpur *Atharah Garh*.

"The Zamindari of Pendra comprises 12 *Talooks* which, " with the number of villages they " contain, are noted in the margin. " With the exception of the *Talook* " of Pendra it will be seen that the " *Talooks* are generally small, two of " them being entirely waste and un- " cultured. The *Talook* of Koom- " bharee containing 23 villages is " held by a *Talookdar* to whose grand- " father it was entrusted for cultiva- " tion during the time the Zamindari " was under attachment. He pays " to the Zamindar an annual rent of " Rs. 275/-. The Zamindari con- " tains in all 173 villages, 150 of which are under cultivation, " the remaining 23 being waste." When I visited this estate in the course of settlement work some years ago I found among the people a vivid recollection of the *Taluqdari* system. And further I learned that the local name for these areas was not *Taluq* but *Barhon* and for their chiefs not *Taluqdar* but *Barainiha* or *Barah Gaon ke thakur*, or *Dao*.

1.	Pendra	36 villages.
2.	Bargawan	10 (waste).
3.	Deoree	13 (waste).
4.	Andhiarkhoh	17 villages.
5.	Komo	4 ,,
6.	Korgar	5 ,,
7.	Bariumrao	5 ,,
8.	Turkat	11 ,,
9.	Bagra	8 ,,
10.	Korja	24 ,,
11.	Seonee	16 ,,
12.	Kumbhari	23 ,,
	and one village held rent-free by the Nerbudda Debi.	

22. Pendra is not the only *Garh* in which the existence of these *Barhons* is recorded. Matin, Uprora, Chhuri, Champa and Lapha, Zamindari Estates in the Bilaspur District, also appear in the lists of *Atharah Garh* subordinate to Ratanpur, and in all of them clear traces of *Taluqs* or *Barhons* existing as interior subdivisions of the *Garh* are to be found. The Settlement Officer of Bilaspur District had nothing to say on the subject of these *Taluqs* in 1869. There is not a single reference to them in any of his reports. But in 1859 and 1864 the Deputy Commissioner called for information as regards the income derived from each Zamindari in considerable detail, and we still possess the vernacular replies to his reference. In the replies (in all of which by the way the Zamindaris are referred to as *Parganahs*) the following detail of *Taluqs* is recorded. In Chhuri Zamindari we find :—

1. The *Taluq* of Patpara with 8 villages.
2. The *Taluq* of Irap with 15 villages.
3. The *Taluq* of Jawali with 4 villages.
4. The *Taluq* of Nonera with 8 villages.
5. The *Taluq* of Arda with 19 villages.
6. The *Taluq* of Dhangaon with 16 villages.
7. The *Taluq* of Chaitma with 10 villages.
8. The *Taluq* of Dongri with 6 villages.

9. The *Taluq* of Sungurha with 12 villages.
10. The *Taluq* of Jurali with 20 villages.

On page 313 of the Bilaspur District Gazetteer there is also specific reference to two *Barhons* of Umreli and Kothari taken from the Champa *Garh* to be included in the Korba Estate.

In *Uprora* Zamindari the lists record—

1. The *Taluq* of Malda with 4 villages.
2. The *Taluq* of Binjhra with 2 villages.

The remainder of the estate is classed under the head " Uprora " as being under the Zamindar's direct control.

In *Matin* Zamindari the lists record—

1. The *Taluq* of Gursiya with 1 village.
2. The *Taluq* of Lad with 3 villages.
3. The *Taluq* of Ghosra with 3 villages.
4. The *Taluq* of Sirri with 16 villages.

In *Lapha* Zamindari the lists record—

1. The *Taluq* of Pondi with 5 villages.
2. The *Taluq* of Tuman with 7 villages.

In the case of Kenda alone among the *Sat Garh* is no reference to *Taluqs* made. The above 7 estates, referred to as the seven *Chaurasis* by Blunt in 1795 A.D. and still known as the *Sat Garh* are all included in every list extant showing the *Atharagarh* of Ratanpur. Their internal administration was never interfered with until the 'sixties when British rule commenced. Hence we find here direct evidence of the existence of the system of *Garhs* and *Taluqs* over a large integral part of Chhattisgarh within quite modern times.

23. The Kalahandi Dependency of which some details have been given in para. 11 above, is a remarkable instance of an extensive country which, at any rate up to 1856, was entirely subdivided into small *taluqs* subordinate to the *Garh*. Thus we read in Elliott's report " There remain therefore in the " hands of the Raja five *Garhs*........ The two first are " sub-divided into twelve and sixteen *talooks* whose names " and villages are given in the margin." This is the same organization as that still apparent in the *Satgarh* to the north of Bilaspur only 50 years ago It tallies too with what we should expect to find in the rest of Chhattisgarh, judging from Mr. Hewitt's account of the " *Taluqdari* system " ; and I have therefore no hesitation in concluding that at one time Chhattisgarh like Kalahandi, was a complete network of these small tribal subdivisions, exactly as we find was the case among practically all the aboriginal tribes of Chota Nagpur to the East. Each *Taluq* had its petty chief as Mr. Hewitt expressly tells us (see para. 19 above) and this petty chief regulated his

charge just as his overlord the *Diwan* regulated the *Garh* and as his underling the *Gaontia* regulated the village.

CHAPTER V.

THE NUMERICAL BASIS OF THIS TERRITORIAL DISTRIBUTION.

24. This concludes the first stage of my argument, the object of which has been to establish the existence at one time in Chhattisgarh of a curiously complete system of territorial distribution. But, before going further, it is necessary to emphasize the purely conventional character of the numbers 18, 84 and 12 which have been mentioned in connection respectively, with the *Raj*, the *Garh* and the *Taluq*.

25. Did the *Taluq* regularly consist of 12 and the *Garh* of 84 villages, and were the *Raj* composed strictly of 18 *Garhs*, the inference would be irresistible that the system was not a natural development from within, but was imposed by a single paramount authority from without. We might, for instance suppose that the Rajputs who extended their domination over Chhattisgarh during the 10th to 15th centuries carved it up for administrative purposes into 12 village *taluqs*, seven of which went to a *Garh* while 18 *Garhs* went to a kingdom.

26. This view would seem to receive some support from Elliott's contention (in his Glossary quoted in para. 15 above) that the *Chaurasi* always in origin contained exactly 84 villages neither more nor less. He writes:—"Tod in his "annals of Rajputana, where *Chaurasis* are numerous, remarks "that they are tantamount to the Saxon Hundred. This may "be the case in some respects but it is evident that the "Hundreds rarely contained a hundred villages and sometimes "not even half a hundred....... An extract from Doomsday "Book shows how little uniformity prevailed with respect to "the area and number of manors contained within each "Hundred. Thus we see that Hundreds were never originally "equally partitioned and in this respect they differ from "*Chaurasis*; for there is no *Chaurasi*, even though it may 'have dwindled down to ten or twelve villages, of which every "originally component village could not, according to local "tradition, be pointed out by the neighbouring Zemindars, so "that *Chaurasis* once comprised theoretically, (however inexactly in certain cases) as the name implies, 84 villages."

27. But, however authoritative Elliott's conclusion may be in regard to the North-West Provinces with which his enquiries were more particularly concerned, there is no question but that in Chhattisgarh the numerical system had no exact significance. Even in the North-West Provinces Elliott's view was questioned by his editor who, in a footnote to the

article on *Chaurasis* wrote :—"It is extremely doubtful "whether the *Chaurasis* enumerated in the text did always "consist of exactly 84 villages. In the cases of which I have "had personal cognizance I have had reason to doubt the "fact. I think the most reasonable supposition is that, as the "territories of some powerful clans did really contain 84 "villages, it grew to be a *habit* with others who had a large "settlement in one place, to call it a *Chaurasi* also."

28. As for Chhattisgarh and the neighbouring territories, a very slight acquaintance with the tract and a knowledge of the frequency with which villages in this backward country are, even to-day, established and abandoned, would suffice to convince one that the number *Chaurasi* was a mere approximation ; and in the Rewah Gazetteer, quoted above in Chapter III, it is expressly stated that "*Chaurasi* was the most common *convention* of naming *Parganas*." I am prepared to go so far as to assert that in no instance in Chhattisgarh did any of the so-called *Chaurasis* exactly consist, at any time in its history, of 84 villages. And the reason is obvious, namely that, as will be shown in Chapter VII, the system of *Garhs* and *Barhons* was a direct derivative of the clan and minor clan. Such tribal settlements might, over a large territory, as a result of practical convenience, be found to be approximately constant in size. But it is incredible that any aboriginal group still in the tribal stage should partition its settlements on a strictly numerical basis. Hence we find the conventional numbers so extremely inappropriate. For instance, it is on record that Chhattisgarh at one time contained 48 *Garhs* (see Mr. Chisholm's Settlement Report of 1868, para. 56); that Pendra though a *Chaurasi*, actually contained according to our earliest report of 1860 (see para. 18 above), as many as 173 villages; and that the Taluqs in the same estate, though known as *Barhons*, were composed of any number of villages from 4 to 36, not one of them containing exactly twelve. I conclude, therefore, that in Chhattisgarh a correct and numerically constant distribution of the country into *Atharagarhs*, *Chaurasis* and *Barhons* was not, either in the first instance or at any later stage, an essential feature of the local territorial system. That system was aboriginal and indigenous. The nomenclature was artificial, a foreign importation of a later date.

29. As a proof of this contention it is only necessary to observe that we find elsewhere the same numerical system carried to absurd lengths. In the "History of the Garha-Mandla Rajas" (Garha-Mandla immediately adjoins Chhattisgarh) written by Sleeman and published in Volume VI of the Journal of the Asiatic Society in August 1837 we read that Sangram Sa ruled over 52 *Gárhs* or Districts. A list of the 52 Garhs is included in the History and the number of villages comprised in each Garh is entered against its name. No fewer

than 35 *Garhs* are shown as containing *exactly* 750 villages each, while the remaining 17 contain precisely either 350 or 360 each. The total number of villages in the kingdom is thus stated to have been 32,280. The number 52 is also merely conventional as, in the well-known Ramnagar inscription (No. 77 in Rai Bahadur Hiralal's list), we find 52 generations of this dynasty recorded, while of Sangram Sa it is stated that "when he had ordered the orb of the world" he constructed 52 fortresses[1] "indestructible from their excellent fortifications." Such extravagances at once disclose the conventional character of these numbers. On the other hand the *system* which they indicate was real enough. Grant, on p. 79 of his Introduction to the C.P. Gazetteer of 1870, quotes a passage from some manuscript notes written by Sleeman in 1825 (now unfortunately lost) which probably gives us as Grant says "a very fair idea of the internal polity of the Gond principality" of Garha-Mandla. Sleeman wrote: "Under these Gond Rajas the (Nar-"singhpur) District for the most part seems to have been "distributed among feudatory chiefs bound to attend upon the "prince at his capital with a stipulated number of troops to "be employed wherever their services might be required but "to furnish little or no revenue in money. These chiefs were "Gonds and the countries they held for the support of their "families and the payment of their troops and retinue little "more than wild jungle." Here once more we find evidence of a mixed feudal and tribal organization. Its development in a Gond kingdom proclaims its primitive origin, while the use of such extravagant numbers to describe it shows how purely conventional that description was.

30. If then *Atharagarh, Chaurasi* and *Barhon* had no essential numerical significance in Ratanpur and Raipur, how did they come into common use? My belief is that the terms were introduced from Central India by the Rajput conquerors. Thus Elliott in his article on *Chaurasis* writes :—

"This is not the place to enter as fully as the interesting "nature of the subject demands, into the enquiry when *Chau-"rasis* were first introduced into the Mythology and Administra-"tive details of India; but it is obvious to remark that the Bud-"dhists and Jains were more partial to the number than the "Brahmins; and that the Rajputs, of whom the Agnikula "portion appear to have been supporters of the Buddhist "doctrines more particularly affect that number than any "other tribes at present found in the occupation of the soil "...........It is moreover very remarkable that Manu

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[1] See also Tod's Rajasthan under "Annals of Haravati" where Macavati-nagari with its 52 castles is identified with Garha-mandla. Clearly Sangram Sa was merely aping the Rajputs in boasting of his 52 Garhs.

“ uses only the decimal division when speaking of the Civil “ Administration. ‘ Let him appoint a lord of 10 towns, a lord “ ‘ of 20 towns, a lord of 100 towns and a lord of 1,000 towns’ “ ...... As, therefore, there is nothing in Manu which can “ be construed into the remotest allusion to *Chaurasis* we “ must look for their introduction to some subsequent period; “ and in the midst of much uncertainty it seems lawful at “ least to conjecture that the most probable date is that when “ the Buddhists from Scythia immigrated to India and became “ incorporated with the tribes who were in previous occupation “ of the Country.”

It is certainly true that the term *Chaurasi* is far more common in Upper India than it is in the Central Provinces. So far as it is found in the latter Province it may be taken as a term adopted under Rajput influence by a society who wished to strengthen their claims to a Rajput connection.

31. Again, as regards the term *Barhon* I found after considerable enquiry that it was in use in the Jhansi District. At page 31 of Vol. VII of the Archaeological Survey of India in a report of a tour in Bundelkhand and Malwa in 1871-72 Mr. Beglar wrote: “ About 4 miles east of Gursarai and half a “ mile off the road there is a cluster of 12 villages called Sirwa “ *Baron*. Of these a few only are named on the map. In the “ midst of these villages which are all situated close to each “ other at the foot of a clump of hills are two tanks Aman Tal “ and Ray Tal. Both are ascribed to the Chandels.” Of the Rajput origin of the Barhon in the Jhansi District there can be no question.[1]

32. Finally there is no doubt about the Rajput origin of the term *Atharahgarh*. I have already noticed in paras. 8 to 10 above the earliest reference to the use of 18 as indicating the number of parts properly composing a whole Kingdom—the 18 *Mandalas* of the Chedi Kingdom of Tripuri, and the 18 “ forts

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[1] That this 12-village system was at one time widespread in the Jhansi District would appear from para. 55 of a Report on an elementary system of Punchayats in the United Provinces of Agra and Oudh by Mr. C. A. Phelps, I.C.S “ A word should be added about Garhwaro Panches “ in Jhansi. Garhwaro is apparently from Gerohwala and refers to a “ group of twelve or sometimes fifty-four villages which in Maharatta “ times shared one large Appellate Panchayat. Important disputes were “ settled by this Tribunal which had recourse to ordeals, lots and other “ unorthodox methods when matters were not made clear by oral “ evidence There now survive very few traces of this primitive institu“ tion.”

The Collector of Jhansi in a letter to the Local Government also wrote in 1916 as follows:—“ Traces of Appellate Panchayats called “ Garhwaro probably from the circumstance of their being convened at “ the Local Baron’s *fort*—show that Punchayats received the support of “ the old native rulers.” (Letter dated the 3rd November 1916 from the Collector of Jhansi to the Secretary to the Government of United Provinces).

of adversaries" overthrown by Simhana Deva. These are all clearly Rajput conceptions and the *Atharahgarh* of Sambalpur and Kalahandi are certainly imitations of the same Rajput idea.

33. I have shown that in Chhattisgarh the terms *Atharahgarh, Chaurasi* and *Barhon* were conventional, and were introduced by the Rajput conquerors from Central India. But it would be in my opinion, useless to attempt to find a reason for the selection of these numbers. In almost every country enquiry will disclose a series of "Sacred numbers" with a legendary story of account for them.

34. Beames, in Elliott's Glossary explains the popularity of such numbers on an astronomical basis "As 360 is the "multiple of the number of months in a year with the number "of days in a solar month........so is 84 the multiple of the "number of months with the number of days in the week.... "......It is needless to particularize all the instances in which "the partiality of the natives of India for the numbers 7, 12 "and 84 is shown." He then quotes a mediaeval writer who referred the origin of chess and backgammon to the preference for certain astronomical numbers and proceeds "Let us take also "the emblematical figure of *Surya*, the Indian Sun. He is "represented with 12 spokes to his wheel indicating, as the "Bhagvata expressly says, the number of months, and sitting "under a canopy formed by the 7 heads of the Coluber Naga. "He is also represented driving 7 steeds and also has 12 "titles, forms or manifestations which denote his distinct "powers in each of the twelve months throughout his passage "through the ecliptic. The allegorical import of this *Chaurasi* "is so evident that we need go no further to assign causes for "the selection of this multiple of 7 and 12 to represent terri-"torial subdivisions in India; no numbers being considered "more appropriate for that purpose than those which bear "reference to the motion of the earth, the revolving seasons, "and the succession of seed time and harvest."

35. As something of an antidote to this rather sublime explanation of the common use of the term *Chaurasi*, I may quote the following from Henry Kingsley's Ravenshoe (Chapter XXIV). "The natives (in Australia) are very low savages, "are they not, Mr. Smith?" said William. "I have heard "that they cannot count above ten." "Not so far as that" "said Mr. Smith. "The tribe we were most among used to "express *all* large unknown quantities by 'eighty-four'; it "was as *x* and *y* to them. That seems curious at first, does it "not?" William said it did seem curious, their choosing that "particular number. But Mr. Bidder, trying to mount his "hobby horse and not caring how, said it was not at all "curious. If you multiplied the twelve tribes of Israel into "the seven cities of refuge, there you were at once. Mr. Smith

"said he thought he had made a little mistake. The number "he fancied was ninety-four. Lord Saltire, from the card "Table, said that made the matter clearer than before. For "if you placed the Ten Commandments to the previous result "you arrived at ninety-four which was the number wanted. "And His Lordship, who had lost and was consequently pos-"sibly cross, added that if you divided the whole by the five "foolish virgins and pitched Tobit's dog, neck and heels, into "the result you would find yourself much about where you "started."

In a foot-note to the passage above quoted Kingsley certifies to this indefinite use of the number 84 by a "certain tribe" (presumably Australian) as actually employed "to the author's frequent confusion."

36. Personally I think, there is little profit in pursuing any enquiry as to how numbers such as 12, 18 and 84 came to be preferred to others. I am content to accept the fact that they were preferred, and to use this fact in making an attempt to piece together the outlines of an obscure Hindu polity. These numbers help us, when nothing else can, to form some faint idea of how the territory of Chhattisgarh was organized in mediaeval times.

CHAPTER VI.

THE SAMBALPUR ATHARAHGARH.

37. I have referred in para. 8 of this paper to the Sambalpur *Atharahgarh* as another instance of an organization similar to the *Atharahgarh* of Ratanpur, of Raipur and of Kalahandi. But this straightforward analogy presents some difficulty since, according to modern local tradition as officially recorded, these Sambalpur *Garhs* were not, as in Chhattisgarh and elsewhere, *interior* subdivisions of the kingdom itself, but constituted (it is said) the units in a cluster of 18 independent States (of which Sambalpur was only one) in feudal subordination to or confederation with the Rajas of Sambalpur and Patna.

38. In a footnote to para. 27 of his Report of 1863 on the Central Provinces Zamindaris Sir Richard Temples writes :— "The Sambalpur and Patna Rajas are sometimes said to be "descended from or related to the Royal or independent "Haihaibansi dynasty of Ratanpur in the Chhattisgarh plateau "which was formerly the capital of Chhattisgarh. Enquiry "on this point has failed to establish it one way or another. "But it may have some foundation. The Chieftainships

“ which formerly owned allegiance to Sambalpur and Patna [1] were, including those two, eighteen in number. They were known for many ages as the *Atharah* (18) *Garh*, just as the adjacent country to the west was called and is still known as the *Chhattis* (36) *Garh*. The fact gives some colour to the story that the Haihaibansi rule at one time included the Sambalpur and Patna Gurhjats; and when the Ratanpur kingdom was dismembered it may have been that the *Atharah-garh* were assigned to the Raja of Patna or perhaps to some remote ancestor of whom even tradition is silent.” [2] Sir Richard Temple then proceeds, in a foot-note to para. 30 of his report, to enumerate these *Atharahgarh*.

39. Sir R. Temple's list of the Sambalpur *Atharah Garh* is based upon excellent local authority. There is an interesting Report entitled “ Notes on the Gurhjat States of Patna” by Major H. B. Impey, Deputy Commissioner of Sambalpur, dated 29th May, 1863, which gives an account of the rise of the Sambalpur and Patna confederacy, describes it as a cluster of “ *the* 18 Garhs,” and gives the following detailed enumeration of these states :—

1. Patna.
2. Sambalpur.
3. Sompur.
4. Bamra.
5. Rehracole.
6. Gangpur.
7. Bod.
8. Athmalik.
9. Phuljhar.
10. Bonai.
11. Raigarh.
12. Bargarh.
13. Sakti.
14. Chandarpur.
15. Sarangarh.
16. Bindranawagarh.
17. Khariar.
18. Borasambar.

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[1] Sir Richard Temple, exactly following in this Major Impey's report referred to in the text, himself recognizes the term *Garh* as indicating the *interior* sub-divisions of a single State. On page 51 of appendix B to his Report (Reprint of 1908) he writes: “ The Zamindari of Patna has, the present chief alleges, been held in his family by direct succession for 32 generations whose progenitor emigrated from the Gangetic Doab, and through the influence of the Ruler of Orissa, established himself as ‘ chief of the eight *Garhs*’ noted in the margin, lying to the south of the Mahanadi and comprised in the tract enclosed by the rivers Ang, Mahanadi and Tel.”

1. Patna.
2. Salabhala.
3. Kongaon.
4. Jhorasinga.
5. Sindekela.
6. Kholagarh.
7. Gurhagarh.
8. Kumragarh.

[2] There is indeed some indication that at one time in the 16th century A.D. the Haihaibansis had reduced all the neighbouring States, Sarguja, Sambalpur, Bastar, Kalahandi and even Singbhum to the position of tributaries, but the rest of Sir Richard Temple's inferences from the use of the term Atharahgarh have no foundation. There is nothing to support the suggestion that the Rajas of Sambalpur and Patna were related to the Haihayas, or that Sambalpur was at any time an integral part of the Ratanpur Kingdom which was subsequently assigned to the Patna Rajas.

40. Nor is this the only evidence we possess in this connection. A certain Lieut. Kittoe visited Sambalpur as far back as 1838 and specifically writes :—

"Touching the state of Sambalpur it was (previous to its "dismemberment) subdivided into 18 garhs or chieftainships "held in fief of the Lord Paramount who resided at Sambalpur, "and called therefore *Atharah Garh Sambalpur.* Amongst these "were Bod, Sonpur, Gangpur, Udaipur, Phuljhar, Sarangarh, "Saronda, Bonai, Bamra, Lehrakol, Rehrakhol and seven "others including Sambalpur itself; most of these however "have long since thrown off their allegiance and ceased to pay "tribute or to furnish their quota of Paiks (militia)."

41. In spite of the weight which must attach to precise records of the kind just quoted clearly in full accord with current local tradition, there is no question but that this description of the Sambalpur *Atharahgarh*, as comprising in addition to Sambalpur itself a number of extensive States outside and around it, is historically incorrect. I do not deny the existence at one time of a large cluster of States in subordination to Sambalpur and Patna. But the application of the term *Atharahgarh* to this confederacy is mistaken. This is an assertion which at first sight must seem presumptuous. Here we have a list of 18 States based on local tradition and on recorded evidence which goes back to 80 years ago. The tradition is accepted in every official record, we possess—in Gazetteers new and old, in local histories, in Aitcheson's Treaties and in all accounts of the country which are based on these. And there is precedent for such confederacies.[1] It may well seem a bold undertaking to attempt to prove that so many competent

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[1] It cannot be denied that the number 18 was, in very early times, applied to confederacies of states. Two such cases are on record. In the Plates of Samkshobha dated 518 A.D. there is a reference to a cluster of "18 forest kingdoms" subordinate to Dabhāla. (See No. 28 of Vol. VIII of the Epigraphia Indica and No. 107 in Rai Bahadur Hiralal's Descriptive List of C.P. Inscriptions). And in a footnote to p. 197 of his "Village Communities." Baden Powell writes: "One of the most frequent features of Hindu States especially those not on the clan system, "is that they are combined in confederacies and united under the "hegemony of some great emperor like Asoka or the sovereign of Kanouj. "The Chinese pilgrim in the seventh century saw the state barge of "Kanouj being drawn by 18 minor Rajas. This confederacy did not "imply any interference with interior state affairs, only with general "defence and offence." But we have to note that these are both very obscure precedents, dating from the early centuries of the Christian era long prior to the arrival of the Haihaibansis in Chhattisgarh. They refer to something much more extensive than the petty group of states round Sambalpur, and both of them represent 18 *subordinate* kingdoms in relation to a sovereign who holds an independent territory making 19 states in all. The *Atharahgarh* which we find in Tripuri, Ratanpur, Raipur, Bastar and Kalahandi are, on the contrary, combinations of 18 units constituting in themselves an independent political entity.

authorities have erroneously applied the term *Atharahgarh* to a cluster of 18 States of which Sambalpur was one instead of to the internal subdivisions of the single State of Sambalpur. But the attempt will be made and I venture to think will be made successfully.

42 Let us begin by making reference to a still earlier and more reliable authority even than Lieut. Kittoe. Kittoe was in Sambalpur only for 19 days in 1838. A certain Mr. Motte, who came to hunt for diamonds, spent, to his grief and pain, from May 31st to October 2nd in this outlandish spot in 1766. Not only had Motte far greater opportunities for acquiring information by reason of his lengthy stay, but he was at Sambalpur only 11 years after this so-called *Atharahgarh* of States came under Maratha rule. As Sir Richard Temple (on the authority of Major Impey) tells us: "The earliest authentic "information we have of the Sambalpur Garhjat Chiefs is that "they were first independent; then they held in subordination "to the most powerful of their number, the Maharaja of Patna. "In later times the Maharaja of Patna was forced to share his "supremacy among the chiefs with his relative the Maharaja "of Sambalpur and *this was the situation when all fell under the "dominion of the Marattas in A.D.* 1755 *as tributaries.*"

43. Now it is hardly credible, if the confederacy were known as the *Atharah Garh Sambalpur* as Kittoe tells us, that Motte should fail to be aware of it. He was almost a contemporary writer, while Kittoe and Temple are describing a condition of affairs which had "long since" passed away. On the contrary, Motte makes no mention whatsoever of any past or present subordination of the surrounding Gurhjat States to Sambalpur, and, although Sir Richard Temple asserts that this confederacy was "known for many ages as the *Atharahgarh*" and that it continued in existence at least as late as 1755, Motte in 1766 treats the term *Atharahgarh* as a conventional title of no particular significance and describes it merely as one "common among the Hindus." Let me quote from his narrative the perusal of which, as Lieutenant Kittoe remarks in his Report, will "amply repay the reader for his trouble."

44. *After passing through Bod into Rairakhol* he writes: "May 28th—In the morning my servant told me the *Killedar* "of the village was resolved not to let me pass unless I made "him a present. I marched the Sepoys telling the *Killedar* "I would burn every house to the ground. This menace had "the desired effect. He let me pass without the least moles"tation. Nine miles from hence I *entered the province of Sambalpur.*" Later he writes: "The Sambalpur province is so called "from its capital, but the Rajah takes the title of Rajah of "eighteen forts. *Such titles are common among the Hindus* and "I doubt if the capital of the Mahrattas which we call Sat"tarahgur or the Star fort is not Sattarahgur or the seventeen

"forts, for Sattarah is not a star in any of the Hindu languages. "There are two Rajahs of 36 forts—one in the Allahabad "province, the other to the northward of Lucknow. The "province (of Sambalpur) extends from latitude 20°50′ to "22°15′ north and from longitude 83°28′ to 84°50′. It is bounded "to the west by the countries of Borashumber (Borasambar) "and Rottunpur; to the east by Bimbara (Bamra), Lundacole "(Rairakhol) and Bod; to the south by Patna and Coondon "(Kharond); to the north by Gungpoor and Soorgooja. Rottunpoor is subject to Bimboojee....Patna which means in "the old Hindu language what we call caravanserai is now "so changed from its original name that the people will not "suffer a stranger to enter the country......The rest of the "countries above mentioned are small and insignificant." Finally on leaving Sambalpur he writes: "October 4th. Twelve "miles from Whoamah I passed the bounds of the province of "Sambhulpoor and entered that of Jonepur (Sonpur). Jonepur "is a large town situated at the conflux of the Mahanuddee "and Tail rivers the Rajah of which is dependent on Janoojee. "The Rajah took no notice of me nor I of him."

45. It is obvious from the above account that Mr. Motte in 1766 knew nothing of the "Cluster of States" of which Lieutenant Kittoe in 1838 and Sir Richard Temple in 1863 had so much information. The territories of the "Sambalpur Province" are clearly defined and clearly differentiated from the adjoining "countries," and the title of "Rajah of 18 forts" is treated as a merely conventional designation, but one manifestly having reference only to the "Sambalpur Province"—not to any cluster of states around it. It is surely curious too that, though Mr. Motte has nothing to say as regards this "Atharahgarh" of States, Kittoe some 70 years later can give a partial list of the members of the confederacy which Major Impey in 1863 records in the fullest detail. Such a development of information varying inversely with the writer's proximity in time to the state of affairs he is describing is in itself suspicious. And this alone might tempt one to conclude that the application of the term *Atharahgarh* to the states which at one time acknowledged the hegemony of Sambalpur and Patna is without historical foundation.

46. We may turn to consider how far the ordinary meaning of "Atharahgarh" as indicating certain *interior* subdivisions of a Raj can be applied to Sambalpur. It will be found that such a use of the term is perfectly consistent with Mr. Motte's description of the Sambalpur country. As the number *Atharah* in itself had no precise significance he made no effort to apply it. But his description of the internal organization of the "Province" is curiously analogous to what we know was the condition of Ratanpur and Raipur about the same time. He writes: "The Government of Sumbhulpoor

"is strictly feudal, the fiefs of which being originally official "are by the weakness of the Sovereign become hereditary: "and indeed the feudal governments tended rather to an "aristocracy than to any other form, since it was natural for "a man possessing an official fief to wish to make it hereditary, "and for the possessor of an hereditary fief to be jealous of "his sovereign who was alone able to deprive him of it. The "principle of a feudal Government is self-preservation which "is ever accompanied by a watchful suspicion. It is the "interest of the sovereign to foment dissensions among the "*lords*. The lords are attended by large bodies of guards "which they call state: these frequently produce quarrels "between their masters, which if the sovereign can aggravate "so as to bring them to blows with each other he has only to "take the part of him who has best interest among his com-"peers and resume the fief of the other; so that during a long "reign the sovereign becomes opulent and powerful. On the "other hand during a minority the estates which devolved to "the crown being thrown away on favourites or, what is worse, "on uncles and brothers, a superior is raised like the cursed house "of Lancaster which involved England in troubles during up-"wards of two centuries. It appears from the history I have "given that all the evils attending the feudal system were "centred in this Government, for such is the danger of degrad-"ing a man from an office that it is seldom effected without "murdering him; for, if he can fly to his fief, he is able there "to raise an opposition dangerous to the sovereign. The former "*Dewans* were possessed of villages at a distance from the "Capital and were of course liable to surprise; but Akber the "present Dewan's power lay in the capital itself so that he "was mayor of the palace and made the Rajah prisoner at "last."

47. These references to a feudal system, to fiefs and to Lords of Estates, all indicate that the country was internally subdivided just in the same way as Chhattisgarh, and so strong was this system that signs of it have continued down to modern times. No fewer than 16 Zamindaris "tracts held by "intermediary Proprietors having a feudal status" are mentioned as forming part of Sambalpur proper in the latest Gazetteer (published in 1909, page 164). We also read that "certain of the Zamindars are locally known by the title of "*Garhtia*, i.e. literally a fort-holder" and (ibid., page 169) that "the feudal tenures called Zamindaris appear to have origina-"ted to several ways. Ten, viz. Kolabira, Machida, Kodo-"baga, Laira, Loisingh, Kharoal, Paharsugira, Dehral, Patku-"landa and Mandomahal are owned by Gonds and are be-"lieved to represent fragments of the *ancient Gond Raj* which "once extended over large areas in the Central Provinces "....... Whatever their origin may have been, it appears

" that, before the district came under British Administration " while it was under the rule of the Rajas of Sambalpur, the " *Zamindaris were service tenures* held on payment of a small " tribute called *Takoli*, subject to the proviso that the proprietors were *bound to render military service* when called " upon." Here we find clear indications of an arrangement exactly analogous to the Chhattisgarhi System, and I therefore conclude that these Zamindaris are the relics of an earlier system of *internal* administration which gave rise to the term *Atharahgarh*.

It is at least obvious that the feudal system described by Motte has reference to the organization of Sambalpur itself, and not to the relations of the Sambalpur king with the adjoining " countries." This feudal system with Zamindars in possession of Garhs (as may be inferred from their title of Garhatia) is so clearly parallel to the system of Ratanpur and Raipur that, looking to the significance of the term elsewhere, I am satisfied that the title of Atharahgarh was here as elsewhere derived from the existence of these interior units.[1]

48. Nor is Mr. Motte my only witness. It would be easy to disparage his testimony by saying that he was a mere European adventurer, probably ill-acquainted with the language of the country, who, from the fact that he never specified what was meant by the *Atharahgarh* stands convicted of having made but superficial enquiries But I have, by the courtesy of R. B. Hiralal, been given the translation of a poem composed by a certain Prahlad Dube of Sarangarh written in 1783 A.D. to commemorate the installation of one of the Rajas on the Sambalpur " Gaddi." And this poem completely refutes those who regard the *Atharahgarh* as a confederacy of States, and makes it clear that they were internal subdivisions held by local chiefs or " Lords " as Motte would call them. This testimony is unimpeachable. It was prepared

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[1] Not only have we this indication of the existence of *Garhs* in Sambalpur but there is also a faint, though unmistakable, reference to *Barhons*. " The Binjhals or Binjhwars are a race of aboriginal descent " who appear to have been among the earliest inhabitants of the district. " Their traditions associate them with the Vindhya hills and their former " home is believed to have been Ratanpur in Chhattisgarh whence they " moved eastward in the direction of Borasambar. A trace of their " former domination is to be found in the legend of the origin of the " Maharajas of Patna......and in the fact that the Binjhal Zamindar of " Borasambar still affixes the Tika to the Maharaja of Patna on his " accession. The more advanced Binjhals, especially the landholders, " boast of an alliance with Rajputs and call themselves *Barhias*, a title " originally borne by small hill chiefs." (Sambalpur Gazetteer, page 76).

Compare also the following extract from page 124, Bengal Gazetteer: Feudatory States of Orisa (1910). " In the Bamra state the Gond " Community is presided over by headmen called *Bariha* who in some " cases hold several villages as their *Jagir*. They are the intermediaries " between the Raja and the Gonds in all caste matters."

by a local poet for a public occasion and must be conclusive evidence on the point at issue.

49. "*Durg Atharah Abhit Chhabi Sambalpur Parsiddh*" writes the poet—"Sambalpur of unmeasured beauty was famous *as* 18 *forts*." Balbhadra Sai one of its earlier kings attacked the neighbouring State of Bod, which both Kittoe and Impey count among the *Atharahgarh*. But Balbhadra Sai makes his attack "along with all his 17 forts" (i.e. the chiefs thereof) so that Bod cannot have been one of them. He lays siege to the Bod King's capital for 12 long years without avail. At last the Chief of Sarangarh is sent for and with his aid the Bod fort is captured. Sarangarh [1] also is thus excluded by the poet from the *Atharahgarh* though Kittoe and Impey include it in their lists. Later coming down to his own times the poet tells us how the Diwan Akbar (mentioned by Motte, see para. 46 above) usurped the Raja's power. The Raja Jaitsingh flies to Sarangarh and seeks help from Chhattisgarh and *Patna* for "*Garh Satrah Kou na aye, namak Chhori Akbar ke bhaye*"—"not one of the 17 [2] forts came (to help him). Untrue to their salt they took the side of Akbar."

In the ensuing battle *Sonpur* comes to Jaitsingh's help. This clearly excludes Patna and Sonpur from the true list of 18 forts. Also Bimbaji writes on Jaitsingh's behalf to all the *Garhs* and all the 13 *Dandpats*, to Bengal, to Chanda, to Mandla, to Patna and to Bamra. Thus we have a clear statement showing that neither Bod, Sarangarh, Sonpur, Patna or Bamra were members of the local *Atharahgarh*. This is in itself sufficient to confute the lists of later writers. But the exclusion of Patna puts the matter beyond all question. Patna was always not merely a member of the confederacy but with Sambalpur the head of it. If *Atharahgarh* indicated any such confederacy it would be impossible to exclude the leading member. The conclusion of the matter then is this. A confederacy of States under Sambalpur and Patna did no doubt exist at one time or another. But it was never known as the *Atharahgarh*. This term referred in Sambalpur as in Raipur, Ratanpur, Kalahandi and Bastar to the internal organization of the kingdom. But in the 19th century its real significance was forgotten while the memory of the confederacy of states survived, with the result that the term *Atharahgarh* was misapplied, a result the more likely to occur as the wider the extension of its meaning the more flattering it was to the traditions of the fallen house of Sambalpur. The title being an old one and its origin obscured by the gradual obliteration of the local system it was easy enough to extend its significance so as to convey the idea that Sambalpur "for many ages" stood at the head of a large confederacy of adjoining states.

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[1] In an earlier section of the poem Sarangarh is described as the "chief Umrao among the 18," but this is a mistake as later on the Raja of Sambalpur when invited by the Chief of Sarangarh to visit Sarangarh replies "on what ground do you take me there? Will you alone take all the 18 Garhs?" which definitely shows that Sarangarh itself was *not* one of the 18.

[2] There is frequent reference in the poem to "all the 17 *Garhs*" and "all the Umraos of the 17 *Garhs*." Clearly Sambalpur *Garh* itself was the 18th. Sambalpur is described as the "kingdom of 120 *Kos* (i.e. 120 *Kos* in length on all sides), the 18 *Garhs* serve it and the 13 *Dandpat* follow them." The 13 *Dandpat* were probably the 13 *Barhons* of the King's own *Garh*. As Capt. Johnstone's report of 1-4-1870 on the Keonjhar estate tells us (vide Appendix to Sir R. Temple's Report of 1863 on the C.P. Zamindaris): "The state is divided into 2 parts...... The whole is further subdivided into Sirdarships called *Pirs* or *Dandpats*." The *Pir* is a common term for the small tribal and territorial subdivision known as the *Barhon* in Chhattisgarh.

50. I am tempted before closing this chapter to draw attention to two conclusions which are forced upon me by this digression into Sambalpur affairs. It is surely a proof of the reality and significance of the term *Atharahgarh* that the analogy of its use in Chhattisgarh enables us to correct an error so deeply rooted as the mistaken interpretation of the term in Sambalpur. It was a fortunate coincidence that written evidence of the 2nd half of the 18th century could be found to correct the fallacies of later writers. But the significance of what Motte and Prahlad Dube wrote would not have been noticed but for our investigations into the meaning of the term *Atharahgarh* in the neighbouring territories of the Haihaibansi kings.

51. Again we are forced by this digression to recognize the extraordinarily unreliable character of much of the evidence which we possess. We can put full trust in no one. The whole period which we are investigating is shrouded so much in the mists of legendary history that at most we can hope to glean a half-truth here and a half-truth there. The early writers were men with few opportunities for study or comparative enquiry. They either like Capt. Blunt in Ratanpur in 1794 fill one with dismay at the opportunities they let slip, or like Motte they write columns of discursive matter in flowing Georgian style without ever coming down to a clear statement of actual fact. But this is not our only trouble. What are we to do when the traditions of the people themselves are so utterly at fault? This story of the confederacy or cluster of 18 States was no figment of Lieutenant Kittoe's or Major Impey's imagination. It was the current tradition of the people of the country. And it is so still. Rai Bahadur Hiralal who served in the Sambalpur District and knows the people well tells me that the *Atharahgarh* are frequently enumerated by those who interest themselves in earlier days. The details given by one are not the same as those given by another. But one and all agree in enumerating what are now the feudatory States round Sambalpur. No one thinks of applying the term

to petty chieftainships inside Sambalpur. Yet the latter is the true interpretation. This throws, as I have said, an interesting sidelight on the character of our evidence. And I trust the character which is thus revealed will be accepted as my excuse for so frequently in these pages condemning evidence as unreliable and yet accepting some portion of it as the basis of my argument.

CHAPTER VII.

CHHATTISGARH BEFORE AND AFTER THE RAJPUT CONQUEST.

52. We may now turn our attention once more to Chhattisgarh proper. Having in earlier chapters described in some detail the system on which in mediaeval times the country comprised in the Rajput Kingdoms of Ratanpur and Raipur was organized, it will be possible by inference from this system and by comparison with adjoining territories where primitive tribal conditions still prevail to form some faint idea of what Chhattisgarh was like before the Rajput conquest.

We have seen in Chapter II that the Kharond or Kalahandi State as described in Elliott's Report of 1856 was organized almost exactly in the form which, from the survivals we possess, we are led to believe formerly existed throughout mediaeval Chhattisgarh—the whole *Raj* divided into *Garhs* and every *Garh* divided into *Taluqs*. Now it so happens that in that State the predominant section of the population are the Khonds, of whose primitive organization we chance to possess particularly full information. "The population of Kharond "(Kalahandi)," Elliott says, "may be approximately stated "at about 80,000. About two-thirds of this number are "*Khonds*." And the importance of the tribe and its original domination in the country are evidenced by the prominent part played by the Khond *Patmajee* on the occasion of the coronation of a new Rajah. The details of the ceremony are described in Elliott's Report, and its "origin is attributed "to a covenent said to have been entered into between some former Rajah (name unknown) and the Khonds of the country."

53. Let us next turn to Lieutenant Macpherson's famous "Report upon the Khonds of the Districts of Ganjam and Cuttack," written in 1841. This document deals at length with the Khonds of the States of Bod and Gumsar, the former of which adjoins the North-East corner of Kalahandi. But it describes the Khonds at a much earlier stage of development while still in practically independent occupation of their country. The legendary alliance between the Khonds and the Raja of which Elliott speaks in Kalahandi is, in Bod and Gumsar, a reality. As Macpherson writes (page 61) the "in-

"dependent tribes in Goomsur form a slightly confederated "group, and are connected with the Zamindary by an alliance "the general nature of which (virtually the same as that bet-"ween the corresponding parties in Boad) has just been indi-"cated."

54. The organization of the independent Khonds was as follows:—"*Each tribe possesses a distinct portion of territory* and "is presided over by an *Abbaya* or Patriarch who is the re-"presentative of its common ancestor. It is divided into "several *branches* which are in like manner ruled by their "family Heads; and finally these *sub-divisions* are composed "of a number of villages each of which is governed by the "lineal descendant of a chief chosen by its first founders. "Each *cluster of tribes* is presided over by a federal Patriarch." (paras. 8 and 9 of Report, Part II, Section I). "The Patriarch "or *Abbaya* of a Khond tribe....is in no respect raised above "the community. He has no separate residence or stronghold, "no retainers, no property save his ancestral fields by the cul-"tivation of which he lives..He transacts no affairs without "the assistance and sanction of the *Abbayas* or of the assembled "society. He leads in war.... At home he is the protector "of public order and the arbiter of private wrongs.... He "moreover *discharges the local duties of Patriarch of his family "subdivision and head of his village.*"

"The position of the Patriarch or *Abbaya* of a branch of a "tribe is, with reference to his limited jurisdiction, exactly "analogous to that of the Patriarch of a tribe. Aided by the "Heads of villages whom he consults and co-operating with "the Chief Patriarch of whose councils he is a member, he "contributes to the same general and local objects. The "*Abbaya* of a village administers its affairs in concert with its "elders." (Ibid., paras. 29 to 32).

It may be added that "the Khond population in these "districts is distributed in the proportion of about 16 inhabit-"ants to a square mile over a country which is entirely parti-"tioned amongst the different Tribes." (Para. 4 of Section I, Part V). "These tribes have existed from a period of the "remotest antiquity as they are seen at present, nearly isolated "by manners, language and prejudices of race from the "surrounding Hindu population, while they have been until "recently completely cut off by the interposed Zemindary "domains, from all contact, from all relations with the successive "Governments which these have acknowledged. To these "Zemindaries they have been attached, individually and in "loosely adherent groups as independent but subordinate "allies." (Part VII, Section I, para. 4). As a great part of Lieut. Macpherson's Report is directed to devising measures for the suppression of the wide-spread practice of human sacrifice it will not be denied that the condition of the Khonds which he described was as primitive as any to be found at that time in the countries adjacent to Chhattisgarh.

55. In an appendix to his Report Macpherson gives some instructive " Statistical Details," of the Bod State which may be abstracted as follows :—

The *Khalsa* or Raja's own domain contains 9 *mutthas* (subdivisions) with 165 villages. The rest of the Estate is divided into Khond " Districts," viz.—

(i) Kotrikia District, with 4 subdivisions or *mutthas* now included in Khalsa.
(ii) Atcombo District, with 8 subdivisions and 59 villages.
(iii) Borogootza District, with 3 subdivisions and 28 villages.
(iv) Bulscoopa District, with 7 subdivisions and 71 villages.
(v) Dommo Singhi District, with 3 subdivisions and 16 villages.
(vi) Oogdoor District, with one subdivision and 10 villages.
(vii) Bagjeer District, with one subdivision and 11 villages.
(viii) Kolobagh District, with 3 subdivisions and 11 villages.
(ix) Bondoghur District, with 2 subdivisions (number of villages not stated).
(x) Burramullick District, with 1 subdivision and 23 villages.
(xi) Punchora District, with 13 subdivisions and 217 villages.
(xii) Satumullic District, with 1 subdivison and 14 villages.
(xiii) Hodgoghora District, with 6 subdivisions and 41 villages.
(xiv) Tentelliaghar District, with 6 subdivisions and 38 villages.
(xv) Chokapaud District, with 12 subdivisions and 86 villages.

56. It will be noticed that the *Khalsa* does not contain at all a disproportionately large number of villages and is broken up into *mutthas* just like the rest of the country. And if we take it and the 15 Khond Districts as representing so many *Garhs* it is obvious that in Bod we have a territorial distribution again strikingly parallel to that disclosed in para. 9 above in the case of Kalahandi. Both Bod and Kalahandi are Khond countries and the inference is, to me, irresistible that the arrangement in Kalahandi is a direct outcome of the earlier tribal system that we see before us in Lieut. Macpherson's pages. We find in Bod itself in the *Khalsa*, where the Khond has been " completely subjugated, and partially assimilated to the Hindu people " by an immigrant Rajput dynasty that the old Khond

arrangement survives by which the domain is partitioned into subdivisions under petty chiefs. And we may reasonably suppose that the system has similarly persisted in Kalahandi.

57. If then we can trace an obvious connection between the Khond Districts subdivided into *Mutthas* in Bod with the *Garhs* subdivided into *taluqs* in Kalahandi it is surely not fanciful to argue by analogy that the *Garhs* and *taluqs* of Chhattisgarh were similarly the outcome of an earlier tribal organization on the same lines as that recorded by Macpherson. The whole trend of the evidence I have recorded points this way and Mr. Hewitt expressly stated that in his opinion the early land system of Chhattisgarh was one " derived from the Gonds " (see above, para. 19). The Gonds are a Dravidian tribe closely allied to the Khonds and the early institutions of both were in all probability closely similar. Bod and Kalahandi are no more than 100 miles from the borders of the Chhattisgarh, and I have therefore no hesitation in concluding that in Macpherson's description of the independent Khonds published in 1842 we can find a realistic picture of the conditions which prevailed in primitive Chhattisgarh when the country was monopolized by its indigenous inhabitants some eight hundred years before he wrote.

Not only is there nothing fanciful in this conclusion, it may be described historically as a common-place, for it is certain that at some time in its history Chhattisgarh was wholly occupied by Dravidian tribes. But it is remarkable that we should be able to trace in modern times the relics of a land system which, by force of comparison with other neighbouring countries, gives us tangible proof of the former prevalence of a primitive tribal organization.

58. Assuming then in Chhattisgarh the existence in early days of this tribal or patriarchal system of which I have borrowed Macpherson's description, we have next to consider under what circumstances did this arrangement become converted into one in which we find a central authority or King regulating the country through a hierarchy of greater Chiefs or *Dewans* and lesser Chiefs or *Taluqdars*. It is usual to ascribe this change to Aryan conquest, and the course of events in Chattisgarh was, I believe, normal in this respect. The date at which this conquest occurred can safely be placed, for our purpose, as late as 1000 A.D. when the Haihayas came to Chhattisgarh There were of course much earlier Aryan settlements at Sirpur on the Mahanadi from the fourth century A.D. and onward, but there is no reason to suppose that these made any very permanent impression on the general population of the country.[1] Even as late as the

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[1] This view is borne out by Mr. Mazumdar (see pages 17, 28 and 29 of his " Sonpur in the Sambalpur tract ") who states (*loc. cit.*) that " the

beginning of the 15th century when the Haihayas conquered "18 Strongholds of Adversaries" we seem to see society in a stage of disintegration which is only compatible with the existence of genuine tribal conditions. Certainly we hear nothing of any centralized opposition to the Haihaya invaders. In any case even if centralized control had at any time been imposed on ancient Chhattisgarh, the bonds of that authority seem to have been broken and the country seems to have split up into its more primitive units at the time when the Haihayas came.

59. In order to appreciate what this Rajput conquest meant we must first disabuse our minds of the popular view which regards the Aryans as fair-skinned, highly civilized invaders over-running a country peopled by black-faced and squat-nosed barbarians. The more we get to know of mediaeval history the more we have reason to minimize the divergence in political, social and intellectual capacity between the Aryan and non-Aryan peoples. The Aryan had developed a monarchical form of rule which, so far as we can learn, was foreign to the indigenous tribes in this part of the country.[1] Being thus organized under a single head it was impossible for the non-Aryan tribes to make any very protracted resistance to them. But in many respects the non-Aryan social and political organization, though independently developed, bore a remarkable resemblance to the Aryan; and when the two systems met they presented no real antagonism to one another.

60. To establish this similarity I may quote from Baden Powell's account of Aryan and non-Aryan customs. As regards the Aryans he tells us (*Village Community*, page 193) that

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settlement of the Hindus and the Hinduized people in the Sambalpur tract cannot be traced earlier than the tenth century A.D.

[1] This is contrary to the view held by Mr. Hewitt. In an article on the Early History of Northern India in which he claims to base his account of Dravidian custom on "a careful examination of the internal constitution of Dravidian States still existing in Chhota Nagpur and *of the great Haihaibansi Kingdom of Chhattisgarh*," he concludes that "the "Dravidians formed their government on the model of their camps, "generally placing the central provinces under the king and settling "there his more immediate followers. The outlying districts were as- "signed to the subordinate chiefs who with their respective forces were "appointed to guard the frontiers." Personally I find no satisfactory evidence to support this conclusion and a good deal (as will be shown in the next chapter) to show that Mr. Hewitt considerably misinterpreted the internal constitution of the Ratanpur and Raipur Kingdoms. But in any case his view hardly touches the present line of argument for he maintained that the Haihaibansis were themselves Dravidians and non-Aryans. So far as he intended to argue that the Haihaibansis were responsible for the introduction of the monarchical form of government I am in full agreement with him. It is their relations with, and influence upon, the earlier inhabitants that I am trying to trace, and on this point Mr. Hewitt has not much to say beyond admitting that the Dravidians (by which he means the Rajput invaders) readily blended with the indigenous peoples whom he calls Kolarians.

"the earliest Vedic accounts always represent them as consisting of differently named tribes and as having *divisions and subdivisions of tribes and clans each headed by its appropriate grade of chief.* Over the whole there is a Raja but very different from the autocratic ruler of later times and evidently not independent of some great popular assembly over which the king presides rather however as *primus inter pares.*" Now if we compare this early Aryan system with the same author's description of some of the non-Aryan tribal organizations there is little difference between the two. Thus of the Boro Kingdom of Assam he writes (*op. cit.*, pp. 135-6 and footnote) that "the country was, as so often observed, divided into districts or areas probably connected with the *clan divisions or clan chiefs' jurisdictions.* The elders and wealthier men formed Councils for the control of internal affairs while the king exercised but a nominal control over the deliberative assemblies. It seems characteristic of the Tibeto-Burman races that they have a number of separate local chiefs who in many cases have no cohesion and no centralized control, so that in the course of time they fall under the dominion of some conquering prince. And even then the sovereign seems always to act in concert with a Council of the Chiefs." Again in writing of Chhota Nagpur Baden Powell summarises his account of non-Aryan custom by saying "whatever then may be the antiquity of the monarchical form among the Dravidians and its claim to be pre-Aryan in point of origin, it is evident that from the earliest times a division of the country—evidently marking the territories of different clans under their Chiefs—was a universal feature. And this prepares us to expect that some minor subdivision inside the *nad* (or clan) was equally ancient........The clan is first subdivided into *mutthas* which I may call the minor clan group, and each *muttha* territory contains a number of hamlets or villages."

61. It is, I think, evident from these descriptions that there could at any rate be no antagonism between the Aryan system of Vedic times and the non-Aryan system of Assam and Chhota Nagpur. It would, for example, be almost as easy to argue that the organization of Chhattisgarh was derived from the one as from the other. I conclude, therefore, that it need be no matter for surprise that the indigenous non-Aryan or Dravidian clan and minor clan groups which the Rajput invader found in existence were permitted to continue, and that the conquerors were content to accept the position of customary over-lords rather than assert their rights by abolishing the natural tribal organization and erecting a centralized official hierarchy in its stead. The Rajputs when they overran the country were still themselves sufficiently in the tribal stage to recognize and retain the indigenous territorial system. But, in their own case, being at a more advanced stage of

social development the tribal system had become to some extent artificial. Their own subdivisions were not the natural formations of the tribal life, but were artificial organizations modelled on the natural formation. And for such artificial organizations the terms *Atharah Garh*, *Chaurasi* and *Barhon* were suitable enough. When the Rajput found himself brought into touch with the purely patriarchal system of early Chhattisgarh he applied his own terminology to it, thus indicating his perception of the fact that what he found in Chhattisgarh was only an earlier stage of his own social and political organization.

62. We must remember too in this connection the extraordinarily accommodating character of the Hindu genius, its aptitude for amalgamation and compromise. Just as in religious matters Hinduism absorbs but never ousts the aboriginal creeds which went before it, so too politically the Hindu conqueror felt no antagonism to indigenous methods of administration. It is a common-place to contrast the bigotry of Islam and the horrors of Mahomedan conquest, involving the extirpation of the infidel, the destruction of his idols, and the assertion of the principle that the conqueror becomes the absolute *owner* of all land in his conquered territory, with the mild give-and-take of the Hindu conqueror in dealing with indigenous peoples, their customs, their beliefs, their tenures and their social institutions. Whether this attitude was due to the teachings of the Hindu creed or to idle acquiescence in the *status quo ante*, or to the political wisdom of the conquering clans, I do not venture to decide. But frequent instances of this spirit of moderation and power of assimilation can be found in local histories. We find the Khond "Patmajee" installing his Rajput conqueror as one Raja succeeds another in the Kalahandi Kingdom. In the wild Sarguja State we read that "there is hardly an instance of the permanent deprivation of any family of local Chiefs of its hereditary possession. The occupant and his immediate heirs were frequently extirpated by the Rajah, but *public opinion* seems to have required that some scion of the house should be sought out and vested with the lands belonging to his ancestors." (Roughsedge's Report, para. 33.) And, as we can plainly see, the whole land system of Chhattisgarh was a compromise and a concession to local custom. Even the Mahrattas at first seem to have displayed the same instinct; for when Bhaskarpant captured Ratanpur in 1741 A.D. he levied a fine of a lakh of rupees from the town but "no violence was done to the Raja Raghunath Singh who in fact was permitted to carry on the government in the name of the Bhonslas."[1] (Chisholm's Report, para. 65.)

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[1] This extraordinary arrangement continued for seven years until Raghunath Singh "threw off the Mahratta yoke." Even then, when he

63. It is to this sense of toleration, that we must attribute the mildness of the change from non-Aryan to Aryan predominance in Chhattisgarh. The Rajput conquerors of early days absorbed no doubt a certain portion of the country for themselves, and demanded the allegiance of the tribal chiefs; but beyond that it is probable that there was, for the mass of the people, no great disturbance of the previous order of things. In fact there occurred in Chhattisgarh much what occurred in Sarguja which, we read, was originally "split up "into a number of tracts inhabited by Dravidian tribes each "under its own chief. These petty chiefs carried on inter-"necine wars one with another and finally some 1,700 years "ago were attacked by a Raksel Rajput from Kundri in "Palamau District, who invaded their territories and reduced "them to subjection." (Gazetteer, Chhattisgarh Feudatory States, p. 227). But though subdued they were kept in possession of their old Estates and retained very wide administrative and political powers right down to the 19th century. Thus Major Roughsedge writes in 1818: "The Rulers must "have conquered Sarguja from the Gonds, Kawars, Korwas, "Khairwars and other aboriginal tribes and it is not probable "that they could have retained their conquest without having "previously established an official authority over their wild "and lawless subjects. *I cannot discover nevertheless any "traces of its exertion except for general purposes*.......... "The Rajah occasionally settled differences between disagree-"ing members of his aristocracy (if I may be allowed the ex-"pression) and whenever he found himself strong enough "marked his dis-satisfaction with any individual by his expul-"sion or destruction. But there is hardly an instance, I "believe, of the permanent deprivation of any family of its "hereditary possessions........A force of horse and foot.... "was always maintained by the Rajahs and mainly contri-"buted to keep the Jagirdars in awe. At the period of Col. "Jones' invasion of that district it consisted of 500 horse and "7 or 800 foot....It will be inferred from the foregoing state-"ment that nothing like police or Civil or Criminal Justice has "existed for many years in Sarguja. The Jagirdars have "enjoyed and very often, I fear, abused the power of life and "death in their respective Estates." (Roughsedge's Report, para. 32).

64. It may be as well at this point to emphasize the fact that the weakness of the central authority was an essential characteristic of the mediaeval polities in and around Chhattisgarh. All English writers whose attention has been drawn to this ascribe it to the degeneracy of the royal house. It was not so.

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was finally deposed on the arrival of Raghoji in 1745 A.D., "5 villages were assigned for his support." (Vans Agnew's Report, page 3.)

It was a regular feature of the system, resulting from a political compromise between the authority of the tribe and the authority of a king. As we have just seen in Vedic times the Raja "is very different from the autocratic ruler of later times and "evidently not independent of some great popular assembly "over which the king presides rather however as *primus inter* "*pares*." And the phenomenon of a weak central power is too ubiquitous in the later times of which I write to be merely accidental. In Sarguja Major Roughsedge can find no trace of the Raja's exercise of his official authority "except for general purposes." In Rewa we read that in 1798 A.D. "The "Rajahs' own dominions scarcely exceed the bounds of his "capital. The extensive territories that nominally belong to "him are distributed in great and small allotments to Kinsmen "near and remote and to feudatories owing military services. "Tribute is either not due or it is withheld; and the rajah "enjoys scarcely any revenue besides that which arises from "duties or customs collected on the merchandize that passes "through Rewa" (Narrative of a journey from Mirzapur to Nagpur). This, no doubt, was an extreme case. But the weakness of the Sambalpur Raja has been fully demonstrated in a previous chapter. In Bastar the king's officers were regulated by popular assemblies (see para. 87 below) and there is significance in Major Vans Agnew's remark in 1821 that "*At present* all the Zamindars are obedient to the Rajah's orders." In Chhattisgarh it was once more the same. "There was no "central authority possessing any vigour" Mr. Chisholm writes in para. 64 of his report: "The Haihaibansis merely stood at "the head of a number of Rajas and chiefs each of whom was "to a large extent independent and among whom the whole "country was divided. It was an essentially weak system "adapted for a peaceful state of society alone." But while we recognize this weakness let us not misinterpret it. It was not due to mere defect in the character and capacity of the local rulers. It was a necessary and ubiquitous incident of a certain stage of local political development intermediate between the tribal system and the system of centralized control.

65. Of course the advent of a Rajput overlord must have had far-reaching consequences When the early people passed from the stage of independent tribes (or of tribes in alliance, as were the Khonds of Bod, with a Hindu power) to one in which their territories formed an integral part of a Hindu Raj, some control of their "internecine wars" must have been imposed, their tribal territories must have been defined, and their tribal leaders must have received an accession of authority from their recognition by the Hindu King. It is easy to understand how a condition of affairs such as this would have led to the regular system described in the first four chapters of this paper—to the definition of the clan and minor clan chief's

jurisdiction as territorial units (the *Chaurasi* and the *Barhon*), and to the promotion of these chiefs to be something more than *primus inter pares* till they are finally recognized as *Dewans* and *Thakurs*. But we may be certain that there was no wholesale expulsion of any local tribe. This was not feasible if the Rajputs had desired it. Even when the Marathas conquered Chhattisgarh in the 18th century they retained the local chieftains in all parts of the country where tribal conditions still prevailed. They were compelled to do so. Still more must this have been the case with the Rajput invaders 800 years before.

It was in these early days of Rajput rule that we would expect to find the territorial system of divisions most complete—the whole country being regularly divided among the local chieftains of whom the great majority were the natural leaders of the local tribes. Chhattisgarh in fact was at a stage of development which was still visible in the Bastar State a century ago. In an old letter of 18-3-1821 Major Vans Agnew writes: "Bastar was originally divided into forty-eight Zamindaries[1] but seven or eight of these have been dismembered and "are now annexed to other states. The *Zamindars each pay a "rent long since established and which does not vary. They "exercise an almost unlimited authority within their respective "Zamindaries but are subject to the Rajah in all that refers to the "general interests of the State. At present they are all obedient "to his orders.*"

CHAPTER VIII.

CHHATTISGARH IN THE 16TH CENTURY.

66. The condition of affairs in Chhattisgarh in the 16th Century of the Christian Era was recorded, apparently in considerable detail, in some invaluable native documents which have now entirely disappeared. Captain Blunt in 1795 A.D. made efforts to secure copies of these during his stay in Ratanpur but without success. The Brahmins of the place gave him a very scanty and inaccurate account of the Rajput dynasty and "more their memory or papers could not furnish" though they admitted that "the whole might be attained by reference to "records which were now difficult to be found." Blunt continues: "Upon my expressing much solicitude to possess them "they told me that they doubted if there were any in Ruttun-

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[1] This subdivision is confirmed by Capt. Blunt in whose Narrative, under the date April 7th, 1795 A.D., we read that "The Bustar Raja "Dorryar Deo and his son Peerkissen Deo are very treacherous and "powerful, having possession of a great extent of territory, divided into "forty-eight Purgunnahs."

" pore for that the oppression and calamity which had befallen " the city since the Maharattas had got possession of it had " destroyed that encouragement which the Brahmans under the " Government of their ancient Rajahs had been accustomed to " receive, that they had been compelled to wander in search of " the means of subsistence and of peaceable retirement else- " where and it might naturally be supposed that they had taken " their books and papers with them." Whether Captain Blunt also failed to render that encouragement which the Brahmans were accustomed to receive I cannot say. Anyhow he went away empty-handed.

67. Sir R. Jenkins in his Report on the Nagpur Territories (p. 91 of reprint of 1901) writing in 1872 refers in passing to "an old Deshwai (Deshbahi) or list of villages found at Ratanpur." So presumably some old documents were seen by Major Vans Agnew (on whose report that of Sir Jenkins was entirely based in regard to Chhattisgarh) but he makes no reference to them himself. Mr. Chisholm the Settlement Officer of Bilaspur District writing of the Haihaibansis in 1869 says (para. 47): "Unfortunately no local annals exist of these from " which could be compiled anything like a detailed history. " The only sources of knowledge on the subject are to be found " in disconnected old documents many of them worn and tat- " tered in the possession of Rewaram Kayasth and Durga Datta " Shastri, the descendants, respectively, of a former *dewan* and " priest of the family." From these he extracts an account which is, as he states, meagre and incomplete. He also tells us (para. 56) that one of the "Revenue Books" of Kaliyan Singh's period (1536 to 1573 A.D.) was in existence in his time containing much interesting information on the condition of Chhattisgarh some three centuries ago and he refers to this "Revenue paper of the time of Rajah Kallian Singh" as being written in 1560 A.D. (paras. 188 and 215).

68. Lastly Mr. Hewitt refers to no less than three ancient documents in paras. 54 to 62 of his Raipur District Settlement Report:—

(1) An abstract statement of the territories and revenues of the Ratanpur kingdom prepared by the order of Kaliyan Singh and dated 1526 A.D.
(2) A List of *Taluqdars* prepared in 1563 A.D. in the beginning of the reign of Lachhman Singh Kaliyan Singh's successor.
(3) A "Deshbahi" prepared at the same time as this list of *Taluqdars*.

Again, in his "Notes on the Early History of Northern India" published in Vol. XX, Part III, Art. VIII of the Royal Asiatic Society's Journal (1888), and in an article contributed to the Asiatic Quarterly Review in April 1887, Mr. Hewitt refers in a footnote to an “account of the Haihaibansi kings and “ their dominions prepared in 1579 A.D. by the *Dewan* of Raja “ Lachman Singh and given to Mr. Chisholm, Settlement Officer “ of Bilaspur, by the Dewan's descendants.”

68. Not a single one of these old documents is now extant. The family of Rewaram, though remembered in Ratanpur, can no longer be traced. In 1908 I wrote to Mr. Chisholm in retirement in England. He replied: “There were Shastris and old “ papers from which most, indeed I may say all, my informa-“ tion was taken. These papers were used by me and no doubt “ returned.” He was unable to give me further information and I spent both time and money in fruitless enquiries of my own in Ratanpur. I am thus reluctantly compelled to suppose that these interesting old documents are irretrievably lost. It is impossible now to form any independent opinion as to their value as contemporary records. But no suspicion was thrown on them by the few Europeans who examined them and I, therefore, presume that they were genuine records of mediaeval Chhattisgarh.

69. The only two persons who have given us any idea of the contents of these documents are Messrs. Chisholm and Hewitt, but their inferences therefrom are so discrepant that it is necessary to deal separately with what each of them has told us. Mr. Hewitt's account of these old documents is as follows :—

“ If the *Deshboee* [Deshbahi] and the lists of *Taluqdars* “ dated 1629 Sambat 1563 A.D. .... are genuine, and I “ see no reason to doubt it, they show that in the time of “ Kaliyan Singh and his son the chiefs of Ruttunpore were lords “ paramount of a very large extent of country extending far “ beyond the limits of Chuteesgurh which formed, however, the “ most valuable portion of their dominions. Besides Chutees-“ gurh *which they held in their own hands* the neighbouring hill “ states of Kourea, Sirgoojya, Chutta Nagpore, Singbhoom, “ Sumbulpore, Kharonde, Bustar, Ambagurh Chokee and Lanjee “ all paid tribute to them, and it may not be out of place to “ note here the amount of the tribute paid by each state.

Ramghur Pertabgarh Kowrea Sirgooja	21,022
Chutta Nagpore Singbhoom	5,001
Ambagarh Chokee Lanjee	12,000
Sumbulpore Bustar Kharonde	5,015
Phuljhar	6,000

“ To defend these territories an army of 14,000 men with 116 “ elephants was kept up.

“The whole revenue of Chhattisgarh is stated to have “ amounted to Rs. 6,57,019 ...... The following may be ac- “ cepted as a very nearly accurate statement of the revenue “ then assessed on Raipore” (with which District as Settlement Officer Mr. Hewitt was alone concerned).

“ Khalsa Pergunnahs.[1] ”

Name of Pergunnah.	No. of Villages.	Revenue. Rs.
Amera	84	4,800
Raipore	640	85,600
Khallaree	84	3,000
Droog	84	15,000
Lowan	252	(84 × 3) 55,160
Seerpore	84	5,000
Tengnaghur (now Kowrea)	84	225
Deeorbeejah	84	13,000
Seersa (doubtful)	84	800
Simgah	84	5,000
Singungurh (doubtful)	84	2,300
Rajim	84	9,036
Patun	152	32,000
Akulwara (doubtful)	84	2,845
Mohdee	84	3,100
Suarmar	84	3,100

“ Pergunnahs held by Subordinate Zamindars.”

Name of Pergunnah.	No. of Villages.	Revenue. Rs.
Dhumda Surda	568	15,513
Balod Sanjaree	795	72,156
Dhumturry	750	81,212
Feringeshwar	84	78
	4,333	4,08,925

“ Of the Pergunnahs held by Subordinate Zamindars “ Dhumda was held by a Gond Raja, Balod and Sunjaree by “ the descendant of the Gond Raja of Mandla, and Dhumturee “ by the Kakeir Raja.”

70. Mr. Hewitt inferred from the above account that the Haihaibansis “ formed their Government on the model of their “ camps, placing the central provinces under the King and “ settling there his more immediate followers while the outlying “ districts were assigned to subordinate chiefs who with their

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[1] Compare the *Atharah Garh* of Raipur given above in para. 7.

"respective forces were appointed to guard the frontiers. They "used the *Parhas* (or tribal *taluqs*) as their local divisions, "*massing them together when they formed an area too small for* "*the provinces* (*or pergunnahs*) *into which they divided their* "*territory*" (vide p. 332, Art. VIII, Vol. XX, Part III of Royal Asiatic Society's Journal "Notes on the Early History of Northern India" by Mr. Hewitt, late Commissioner of Chhota Nagpur). Mr. Hewitt in fact regarded the *Taluq* or *Barhon* as the largest indigenous or tribal division of territory. The *Chaurasi* was to him a purely administrative area created by the Haihaibansis, "the Pergunnahs of the Raipore District "being entered in the old Deshbahi among the estates under "the immediate control of the Government." (Settlement Report, para. 54.) He attaches the modern and therefore, as I admit, the most natural interpretation[1] to the heading "*Khalsa* Pergunnahs" which we find in the list quoted in the preceding paragraph. And all these Pergunnahs he regards as having been administered, I presume, by a staff of *officials* under the centralized control of the Government of Ratanpur. This description is strictly in accordance with what is generally regarded as the normal type of mediaeval Hindu polity, pictorially represented as a flower with open petals round a central disc, the disc being the king's domain and the petals the subordinate estates. But it is not a correct description of mediaeval Chhattisgarh. No doubt there were outlying tributary states which were brought into nominal subjection to Ratanpur or were released from its control according to the strength or weakness of succeeding kings. But it is absolutely incorrect to describe the internal organization of the *Chhattis Garh* as one involving the "immediate control of the Government" or to speak of the Perganahs as being "held in the Rajas' own hands." This assertion entirely disregards the essentially *feudal* character or rather the mixed tribal and feudal character of the old local administration. This is the prime characteristic of the mediaeval system of Government in Chhattisgarh and the countries round it, and it is the description of this tribal and feudal system and the recognition of its place in local history which constitutes the main object of the present paper.

71. Let us now turn to Mr. Chisholm's account. It was he who obtained these old native documents and it was he who had best access to the traditions of the ancient Raj, as Settlement Officer of the district in which Ratanpur its ancient capital was situated. Yet his is a very different story from Mr. Hewitt's. After reciting that his information is derived

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[1] An interpretation which I myself followed in my report on the settlement of the Bilaspur Zamindaris of 1912 and in the History Chapter of the Bilaspur District Gazetteer written in 1909.

from the old documents above referred to (Settlement Report, para. 47) he writes :—

"The Chhattisgarh rajahs ruled originally over 36 forts, "and thus the tract came to be called Chhattisgarh or the "country of the 36 forts.... These forts, as they were called, "were in reality each the headquarters of a *Talooka*[1] compris-"ing a number of villages and held sometimes *Kham*" (i.e. "under direct control), at others as feudal tenures by relations "or influential chiefs. As regards the 18 old Ruttunpore "Divisions compared with the present district of Bilaspur it "may be noted that the first 11 are and have been *ever since* "*Mahratta rule Khalsa* Jurisdiction (i.e. under centralized "control); the following seven were and are still Zamindarees" (i.e. under Zamindars or local chiefs) [paras. 48 and 49]. And if this is not sufficiently explicit let us turn to paras. 187 and 188 of the same report: "Of the early settlement nothing is "known. Judging however from the traditions of the people, "and from the numerous remains *all over the district* of petty "*forts the headquarters of former Chiefs*, the country was appa-"rently divided into a varying number of *talookas* held by the "influential followers or relations of the Haihaibansee rulers. "Villages comprising the *talookas* were held by the farmers "who paid the rents collected from the cultivators to the "*talookdars* who again paid a fixed proportion of their reali-"zations as revenue to the State. The payments doubtless "varied from time to time according to the personal character "and necessities of the Ruttunpore Raja and the comparative "strength or weakness of the *subordinate Chiefs*. In a reve-"nue paper of the time of Kullian Singh (A.D. 1560) whom "tradition represents as one of the most able and powerful of "the old Rajas and after whose death the central authority "became gradually weaker and weaker a list is given of the "Revenue Collections in Chhattisgarh which are represented "as amounting to over 7 lakhs of rupees."

72. Now if the Deshbahis indicated the existence of "immediate control" of Chhattisgarh by the Rajas it is incredible that Mr. Chisholm should refer to these old documents and, in the same breath, describe the country as divided up into *Garhs* in the hands of "subordinate chiefs." The very existence of these forts, as Mr. Chisholm rightly remarks, indicates the feudal character of the system; and is fatal to Mr. Hewitt's view. The traditions of the people also favour Mr. Chisholm, and the methods of organization in neighbouring countries point the same way—the Government of Sambalpur being "strictly feudal" (vide para. 46 above). Bustar being divided into 48 Zamindaris, whose Zamindars "exercise

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[1] He uses the term loosely. In para. 56 he writes: "The Ratanpur Govt. including Raipore comprised 48 *garhs or talookas*."

an almost unlimited authority within their respective Zamindaris" (vide para. 65 above), while Sarguja was in much the same condition (vide para. 63 above). And finally we have Agnew's report from which I have already quoted in para. 16 above to place the matter beyond the reach of doubt.

73. These arguments must finally dispose of Mr. Hewitt's statement regarding the "immediate control" of Chhattisgarh by the Haihaibansi kings. Mr. Hewitt was doubtless misled by the term *Khalsa* used in the old *Deshbahi* to describe the *Perganahs* of the kingdom. The real significance of this term consisted in its indication not that the Chhattisgarh were under the centralized authority of the Rajput kings, but that they were under relatively close control compared with the neighbouring tributary states in the hands of almost independent Rajas, and that *they constituted an integral portion of the Ratanpur kingdom*. The intrinsic inconsistency of Mr. Hewitt's position is exemplified by his remarks about the old *Chaurasis* of Suarmar and Kowrea. The old holders of these estates still retain possession of their ancient *Garhs*. So Mr. Hewitt writes: "Suarmar and Kowrea held by Gonds, were *Khalsa Parganahs* "in the time of Kulhan Sen, but being held continuously by "the old *Talooqdars* their descendants have established a claim "to be regarded as *Zamindars*" (Report, para. 92). How Mr. Hewitt could reconcile the existence of these old *Taluqdars* having all the attributes of "subordinate *Zamindars*" with the record of their estates as Khalsa *Perganahs* in 1560 and therefore under the king's immediate control does not transpire.

74. Captain Blunt in his Narrative of 1795 gives a good idea of the real distinction between tributary States and "Khalsa Perganahs." Matin is one of the best known of the Chhattisgarh Zamindaris. It has been in the possession of its present hereditary chief for centuries, and prior to the present chief's family a Gond chieftain is known to have held the estate. Yet Captain Blunt when he entered the estate on March 3rd, 1795, writes—"crossing the river Hasdo we entered upon "*The Mahrattas' Khas Purgunnah of Mahtin.*" Obviously he merely means that Matin formed an integral part of the Maratha dominions; and doubtless this is all that was meant by the term *Khalsa Pergunnah* in the old *Deshbahi* of the Haihaibansis.

75. I have established sufficiently, I think, the fact that the old native documents do disclose a system of feudal, or mixed feudal and tribal, devolution of control over the greater part of the country held by the Haihayas in the 16th century. But in regard to the details of the organization at that period we get very little help from what Messrs. Hewitt and Chisholm quote from these old contemporary records. Both of these officers seem to have made rather an uncritical examination of

the papers, for Mr. Hewitt's assertion of the Haihayas' 'immediate control' of Chhattisgarh is not the only point of importance in which his reading of the Deshbahi seems to have differed fundamentally from Mr. Chisholm's.

76. It is established beyond the possibility of question that there were two degrees of feudal or tribal intermediaries between the Raja and the Ryot, namely, the chief of the *Chaurasi* or *Garh* and the Chief of the *Barhon* or *Taluq*. But Mr. Hewitt identifies the *Taluq* with the *Barhon* while Mr. Chisholm identifies it with the *Garh.* Though we know for a fact that the *Barhons* were still actually in existence over a large part of the forest country of Bilaspur District at the time of his settlement in 1869 yet there is not a single reference of any kind to this old territorial division in Mr. Chisholm's Settlement Report or in any of his writings which I have seen. On the other hand Mr. Hewitt is equally silent as regards the *Chaurasi.* It is true that he records in his list of *Khalsa Pergunnahs,* already quoted the most valuable evidence we possess as regards the former existence of this 84 village group, but Mr. Hewitt was evidently quite unconscious of the significance of the number. He makes no reference to *Garhs* or *Chaurasis* anywhere in his report though fully aware of the existence of the smaller unit or *Taluq.* Judging from what I have already quoted from his "Notes on the Early History of Northern India" he evidently regarded *Chaurasis* merely as overgrown *Barhons* or *Taluqs* on the few occasions when they came to his notice. The result of this want of discrimination on the part of these two officers is that any information which the old *Deshbahis* contained as regards the further division of the country into smaller as well as larger groups of villages has been altogether withheld from us.

77. Then again, in view of this confusion in the use of the term *Taluq*, what meaning are we to attach to the "Lists of *Talookdars*" dating from 1563 A.D. of which Mr. Hewitt tells us ? Considering that he disregards the *Chaurasi* we would expect these to be lists of *Daos* or *Barhainihas* in charge of 12-village groups. But there must have been many hundreds of these *Barhons* in existence in the 16th century, and it would surely be strange to preserve lists of the minor territorial chieftains while taking no account of the more important *Diwans* in charge of *Chaurasis.* Now we know that the lists of *Taluqdars* were not complete. Mr. Hewitt tells us (Report, para. 62) that they only existed for that part of Chhattisgarh which was later comprised in the Bilaspur District. And Mr. Chisholm in his Settlement Report on that District (though he never refers to any list of *Taluqdars*) clearly identifies the *Taluq* with the *Garh.* He expressly quotes "the Revenue Book of Kullian Sai's period" in para. 56 of his Report as authority for his statement that "the Ratanpur Government at that time comprised

48 *Garhs* or *Talookas*." It is, I consider, almost a necessary inference from this to suppose that the list of *Taluqdars* was not a list of *Daos* in charge of *Barhons* but a list of the old *Diwans* in charge of *Chaurasis*.

78. In regard to the lists in question Mr. Hewitt writes "The Haihaibansi rulers introduced a number of adventurers "from Hindusthan, making over to them the land of the older "settlers; and the lists of Bilaspur *Taluqdars* prepared in the "time of Lachhman Singh show that the greater part of the "*Taluqdars* were of foreign extraction." This is an interesting point. It shows that even by the 16th century considerable progress had been made in the direction of dispossessing the primitive inhabitants by means of more vigorous immigrants from Upper India. At the present time there is a very obvious cleavage between the more primitive inhabitants of the hills and forests and the dwellers in the open plains. The former are Kawars, Gonds and Pankas. The latter are Kurmis, Telis and Chamars. Doubtless the substitution of foreign *taluqdars* for the old local chieftains was a concomitant of this process of dispossession.

79. One other glimpse of these early days is given us by Mr. Chisholm. He tells us (Report, para. 57) that "the army "maintained by Kaliyan Sahai was not of a formidable character. "The following is a detail of its strength :—

	2,000	Swordsmen.
	5,000	Daggermen.
	3,600	Matchlockmen.
	2,600	Archers.
	1,000	Sowars.
Total ..	14,200	men.

"There would also seem to have been maintained an establishment of 116 elephants." Unfortunately we do not know whether these figures represented a standing army or were merely the total of the local levies which the local chieftains were required to put in the field at the bidding of their overlord. We know from Agnew's report that the "Petty Lords" supplied the Raja on his requisition with money according to his wants and "in war with quotas of troops proportioned to "the lands they held" and, looking to the general go-as-you-please which seems to have characterized this old régime, it seems natural to suppose that these figures represent the total of the local levies. If this was so at a time when the Haihaibansi Rajas were at the zenith of their power it is little to be wondered at that in decay the dynasty could offer no effective resistance to the Maratha invaders when they came upon the scene.

CHAPTER IX.

BEFORE AND AFTER THE MARATHA CONQUEST.

80. It will have been made obvious, from what has been written in the preceding chapter that, even by the 16th and 17th centuries, the " theory " of the administrative system as outlined in the 2nd Chapter of this paper had been considerably modified in practice in the more open parts of Chhattisgarh. The original subdivisions of the country which came into existence during the tribal period must have lost their purely tribal character when the primitive inhabitants were ousted by more pushing immigrants. With the primitive people went their chieftains also, whether of lesser or of higher degree; and in their place men of foreign extraction were, as we have seen, introduced by the Haihaibansi Rajas, frequently from Hindustan. The outlines of the old organization too were altered The limits of the *Garhs* were changed and sometimes whole estates seem to have been broken up and redistributed. But amid all that was changing and uncertain one characteristic feature of the system remained unaltered. Though the old order passed gradually away, and the tribal system pure and simple became more and more confined to the wilds and hills in which the Gond and Kawar could still hold his own against the Hindustani, yet the devolution of authority persisted. No attempt was made to centralize control in the Raja's hands, and what may be called a sort of feudal system was gradually in the open country evolved from the old tribal organization.

This at least is the only explanation that can be offered to account for the character of the administration when the Rajput dynasty was overthrown in 1741. In writing of the ease with which the Marathas overran the country Mr. Chisholm says (Report, para. 64). " If at the time the whole " resources of Chhattisgarh and Sambalpur had been exercised " by one central authority the Marathas might have encoun- " tered a really formidable resistance. But as it was there was " no central authority possessing any vigour, and *the Haihai- " bansis merely stood at the head of a number of petty Rajahs " and Chiefs each of whom was to a large extent independent and " among whom the whole country was divided* It was an essen- " tially weak system adapted to a peaceful state of society alone " and must have fallen long previously had any well-orga- " nized foreign invasion ever been attempted. When the Mara- " thas came they marched through the whole country without " any opposition and having substituted their own authority " for that of the Haihaibansi Rajahs they demanded and ob- " tained the allegiance of all the surrounding states."

81. Vans Agnew writing in 1820 has much the same

story to tell. "Under the Haihaibansi Rajahs the feudal prin-"ciples of their rule precluded anything in the nature of a "system of Revenue. The Rajahs and the members of his "family retained no more lands under their own management "than were necessary for their comfort and dignity. The rest "were assigned to their Chiefs who on their requisition sup-"plied them with whatever they required, with money accord-"ing to their wants, and in war with quotas of troops propor-"tioned to the land they held. These petty Lords seem, on "their part, to have followed the same system, retaining but "small tracts of land in their own hands and distributed the "remainder amongst their servants who were at the same time "soldiers and cultivators. The judicial authority in import-"ant cases they personally exercised, but in all inferior and "common occasions they left the chief executive authority in "revenue as well as other matters to the head of each *Taluq* "or village who, it may be concluded, did not act upon any "general or uniform plan. The conquest of the country by "the Marathas changed this state of things and gradually led "to the introduction of their Revenue System in all those "parts of the Province which were sufficiently productive to "repay the trouble of the change During the time of Rajah "Raghojee 1st (1745-55 A.D.) little was done towards estab-"lishing any regularity, although Mohansingh who was left in "charge of the Province by him, was very active and success-"ful in subduing many Zamindars and either making their "lands *Khalsa* or subjecting them to tribute."

82. Here in fact we find history repeating itself, and the Marathas in the 18th century opposed by a number of chiefs in charge of *Garhs* who have to be reduced individually before the foreign domination can be secured, very much, but for the Rajah's presence at Ratanpur and Raipur, as the Haihayas in the 14th century, according to the Khalari Inscription, were confronted by "eighteen strongholds of Adversaries." We see too that the "Khalsa" proper existing in Haihaibansi times was comprised of such lands only as were "*necessary* to the comfort and dignity of the royal family" (perhaps no more than the 640 villages of the Raipur Garh mentioned above in para. 6 and a similar area round Ratanpur); that elsewhere there are Chiefs, obviously in charge of the *Garhs* or *Chaurasis* of which the details are recorded; and that these Chiefs' territories are subdivided into *Taluqs* of which perhaps not more than one is held in the chief's own hands while the rest are distributed among his (so-called) servants, each of whom "in "all inferior and common occasions exercises the chief executive "authority in revenue as well as other matters."

83. This picture drawn by Vans Agnew is very significant. His description in my opinion finally disposes of Mr. Hewitt's contention that Chhattisgarh proper was in the 16th century

under the Rajah's "immediate control." There may be those who are prepared to argue that possibly this "feudal system" was only developed in the last centuries of Rajput rule as the central power gradually weakened, and that its development is not necessarily inconsistent with the view that the Government of the country was actually under the Rajah's direct control in the palmy days of Kalian Singh. In support of this one might quote Motte's opinion on the growth of the similar system of administration in Sambalpur. "The Government of Sambal-"pur" he writes "is strictly feudal, the fiefs of which, *being* "*originally official*, are by the weakness of the sovereign become "hereditary." But this line of argument can be easily met. If the independent position of the petty lords, as Agnew calls them, grew as their strength grew and that of the king declined, how are we to account for the application of this same feudal principle to the relation of the *Taluqdars* inside the *Garh* with their petty Lords? Are we to assume that the *Taluqdars'* strength also grew out of the weakness of the petty Lords? If so, then we should have to go still further and argue that the strength of the *Gaontias* or village headmen was founded on the weakness of the *Taluqdar* and that of the cultivator on that of the village Headman. The mere reduplication of this feudal delegation of authority shows at once that we are dealing, not with an accidental growth, but with a deepseated customary system, which ran through every grade of society and was accepted by all as the only legitimate method of administration. The weakness of the Royal house was not therefore a sign of its degeneracy, but a typical and characteristic feature of the political system then in vogue, and it was typical of the system because that system was originally founded on tribal custom, which always emphasized the rights of the many as against the rights of one. We see in Vans Agnew's account a clear reference to the system of *Chaurasis* and *Barhons* which I have mentioned so often. It is just the system too which we should have expected to develop out of the tribal forms of organization of which we have record in Macpherson's pages, while the mere fact that this reduplication of delegation, this repeated subdivision, persisted longest in the hilly country, where tribal custom still held sway, shows that it was a natural growth and not the fortuitous outcome of the weakness of the central power.

84. If then the argument I have put forward, is accepted a somewhat remarkable conclusion is arrived at. We acknowledge that the system of territorial division which prevailed in Chhattisgarh at the beginning of the 18th century A.D. showed definite traces of its tribal origin in the evident concessions made to customary status. And if this was so at the *end* of the Rajput period, it is impossible to suppose that at any earlier period this tribal element was less in evidence. Changes undoubtedly occurred. The true clan organization, which involved

some tie of kinship between the different grades of society became confined no doubt to the hilly tracts where whole communities of the same tribal status still dominated the country. But strong traces of the same system continued to exist even among the dwellers in the open country. Here the population was mixed. The primitive Gonds were " swamped " by immigrant Telis and Chamars from Bihar and Bhagelkhand, and the *Diwans* of *Garhs* and *Taluqdars* in charge of *Taluqs* were often " foreigners " from Upper India. Yet they seem to have adopted the position held by their Dravidian predecessors. They made no attempt to dominate the tract entrusted to them, or to obliterate subordinate tenures and gather in their own hands the whole administrative control. They too came under the customary code of the country of which the *Panchayat* system was the head and front.

85. Settlement by *Panchayat* is an essential characteristic of the tribal life. It figures very prominently in Macpherson's account of the Khonds where it is obvious that the weakness of the tribal Headmen, each in his degree, resulted from the strength of the *Panchayat*. He writes of the Khonds that " Society is government by the moral influence of its natural " heads alone to the entire exclusion of the principle of coercive " authority....The patriarch of a Khond tribe is aided and " *controlled* in the management of its ordinary affairs by a Coun- " cil composed of the Heads of its branches. These again have " the *Abayas* of villages for their assessors, while the village " heads are assisted by the elders of their hamlets. Assemblies " of the whole population of the tribe or of its subdivisions " moreover, are convened, as usage may prescribe under the " directions of the Patriarchs of each grade to deliberate upon " general or upon local interests. The federal Patriarchs in " like manner consult with the Heads of Tribes and assemble, " when necessary, the entire population of the federal Group. " The Patriarch or *Abaya* of a branch of a tribe aided by the " Heads of Villages whom he consults, and co-operating with " the chief Patriarch of whose councils he is a member, contri- " butes to the same general and local objects. The *Abaya* of " a village administers its affairs in concert with its elders." The same prominence of *Panchayats* coupled with weakness in the authority of the natural tribal Heads is found among the Mundas (see para. 20 above) and is indeed an incident natural to every primitive tribe.

86. This being so, it throws considerable light on the system of administration under Haihaibansi rule to find that *Panchayats* also occupied a very prominent place therein. Vans Agnew tells us that *Panchayats* in the province of Chhattisgarh " are of very ancient date " and after referring to their prevalence under the Maratha Government he continues " As in some measure connected with *Panchayats* it is proper to

"advert to the office of *Panj* which appears to have existed "under all the ancient Governments of this Quarter. Judging "from the duties now discharged by persons called *Panjes* in "the surrounding Zamindaris they would appear to be the "Counsel of the Zamindar and to aid him in all duties of importance. If a negotiation is to be undertaken a *Panj* is "sent. If a civil case is to be decided a *Panj* superintends "the *Panchayat*. If any internal arrangement is to be effected "a *Panj* is entrusted with the duty. In short where a Zamin- "dar delegates any authority it always seems to be a *Panj*. "The situation of *Panjes* under the Haihaibansi Rajas pre- "vious to the Maratha conquest was, it may be inferred, such as "it now is in the Zamindaris the internal government of which "has not been interfered with.[1] After the introduction of "the Mahratta authority however they appear to have been "almost entirely suppressed and persons under that title were "only occasionally nominated as the heads of the principal "Parganahs to superintend arbitration, a duty to which their "former avocations were by no means limited."

87. The position of such a *Panj* is very suggestive. Clearly as the Counsellor attached to the Diwan who held the *Garh* or Zamindari he would constitute a serious limitation upon the latter's arbitrary power. The *Panj* as the name implies was primarily concerned with the working of the *Panchayat* system and, as such, was the repository of local custom for the whole Parganah. Doubtless there were *Panchayats* also for the *Taluq* as we know that there were for individual villages. Whether the royal power was influenced by the voice of the people expressed through the medium of *Panjes* or Panchayats it is impossible to say for certain. But in Prahlad Dube's poem referred to in Chapter VI we read that when the usurper of the Sambalpur throne was parleying with the exiled Raja he suggests that a *Panchayat* should be held to settle their rival claims and that "the *Zamindars* should be called for it." There is also in Bastar (vide No. 213 of Rai Bahadur Hiralal's descriptive List of Inscriptions) a very curious record of a notification of "the elders of the 5 great assemblies and the agricultural class in meeting assembled" in which they denounce the exactions of the King's officers on the occasion of his coronation and direct that such extraordinary levies shall only be collected from well established residents of the villages. If Bastar had such popular assemblies it is not unlikely that Chhattisgarh had them too. There is no direct evidence on the point. But the very fact that the Royal demesne was limited to "no more lands than were *necessary* to

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[1] Note this very clear suggestion that the *Zamindari* system was previous to the Mahratta conquest characteristic of the whole administration under the Haihaibansi Rajas.

the comfort and dignity of the Royal House" seems naturally to suggest that even to the last some lingering idea prevailed that the king was not an autocrat but was rather *primus inter pares*—the administrative, social and religious head but nevertheless bound to regard the customs of his people whose welfare and the maintenance of whose customary rights were of even more importance than the maintenance and extension of the personal authority of the kingship.

88. I conclude from all this that, though the immigrant population had pushed the Dravidian tribes back into the hilly country north and south and west of the Mahanadi basin, yet the tribal form of administration was not, even in the later days of Rajput rule, wholly obliterated in the open country. In so far as the new heads of *Garhs* and *Taluqs* pledged themselves according to their degree to the service of a King or Diwan who was not of their own kith and kin the tie of allegiance was a feudal one, but something of the old customary tribal status still adhered to these foreign chiefs. By accepting a customary status which compelled them to regard the position of those in the social or administrative scale who were lower than themselves, they promptly secured in their turn a customary support of their own status in relation to their overlord. We may call this a feudal system if we like, but, as it was a relation more of status than of contract, I would prefer to describe it as a mixture of the purely tribal and the purely feudal type, since it continued to preserve the primitive tribal ideas of the aboriginal population, while adapting itself to the requirements of immigrants from the north.

89. The whole indigenous fabric was shattered by the Mahratta conquest. The Mahratta came as a conqueror and proceeded at once to develop his position. He soon saw that the systematic division of the country into *Garhs* or Zamindaris and the interposition of *Diwans* or Zamindars and local *Taluqdars* between the ruler and the ryot on whose payments all depended, was a very uneconomic arrangement for a powerful centralized authority. He promptly set himself to oust the Zamindars from all those parts of the country which were sufficiently accessible and fertile to justify the introduction of close official control. As we have it from Vans Agnew, Mohansingh who was left in charge of the Province by Raghoji "was "very active and successful in subduing many Zamindars and "either making their lands *Khalsa* or subjecting them to "tribute." This process continued right through the period of Maratha rule for it is on record that the old Zamindaris of Nawagarh, Mungeli and Pendra were all made "Khalsa" by the Marathas only some 20 years before the country came under British control (1818).

90. The Marathas' treatment of the *Taluqdars* was equally characteristic. They were everywhere in the *Khalsa* turned out

to make way for "needy Brahmins of their own Tribe" who were denominated *Patels*, as Vans Agnew puts it. But not all were Brahmins for he says "they are generally of a higher caste but some are of the lower," and not all were Marathas for he only says of them that "they are frequently strangers who have obtained the situation from interest" (Hewitt's Report, para. 74). But their situation was in no way comparable to that of the *Taluqdar* of Haihaibansi days. The *Patel*, as his name would lead one to suppose, merely farmed the Revenue of the *Taluq* allotted to him by the *Subedar*. As Blunt tells us in 1795 A.D.: "The Subah of Chhattisgarh with "its dependencies was at this time rented by the Berar Govern-"ment to Vithal Pandit for a specific sum which was payable "annually in Nagpur; and who, in consideration of the rank "of Subedar and his appointment, had likewise paid a consider-"able sum. Upon further enquiry as to the means by which the "Subedar managed the country, I was informed that he farmed "different portions of it to his tenants (i.e. the Patels) for a "certain period and for specific sums nearly upon the same "terms as the whole was rented to him. The revenue is "collected by the tenantry which, in those parts of the country "where the Government is well established, gives them little "trouble. The attention of the Subedar is chiefly directed "to levying tributes from the Zamindars in the mountainous "parts of the country, who being always refractory and "never paying anything until much time has been spent "in warfare, the result is often precarious and the tribute "consequently trivial. I was next led to enquire what "method was adopted by the tenantry in collecting the revenue "from the peasants. They informed me that it invariably "consisted in taxing the ploughs and was always delivered in "the produce of the land; and gram, oil or cotton according "to the species of cultivation for which the implements had "been used. This consequently occasions a vast accumulation "of the produce of the country to the tenant and some expe-"dient becomes immediately necessary to convert it into specie "to enable him to pay his rent...... Although much inland "commerce is carried on (by the Banjaras) it derives very "little encouragement from any regulation of the Mahratta "Government as to the improvement of roads, or anything to "animate it, and it is chiefly upheld by the necessity they are "under of converting the produce of the country into specie.."

It was not until a British Superintendent was posted to Chhattisgarh in 1818 that the system of *Patels* was finally abolished and that of dealing direct with the *Gaontias* or Village headmen introduced.

91. By way of indicating the relations which in this part of the country existed between the Marathas and their tributaries lying too far afield to be classed as "Khass Perganahs," let

me quote the following passage from Captain Blunt's narrative. Captain Blunt was told "that since the Mahrattas had "established their Government in Ratanpur and Bhagel "Khand they had demanded a *tribute* from the Chohan Rajah "of Korea which after much contention was settled at 200 "rupees, but that Ram Gurreeb had demurred paying any-"thing for the last 5 years. Gulab Khan had in conse-"quence been deputed by the Subedar of Chhattisgarh with "about 200 matchlockmen and 30 horse to levy the tribute due "to the Rajah of Berar; and had been joined by the Rajah of "Surgooja with about 80 horse and foot. Gurreeb Singh on "his side had been supported by the Rajah of Ningwanny "Goaty with 7 matchlocks and 3 horsemen and his own forces "amounted only to 10 matchlockmen, 3 horsemen and about "100 of the Chohan mountaineers armed with hatchets, bows "and arrows. They had attempted to fortify the pass through "which they expected the Mahrattas would have entered "their territory, but Gulab Khan outgeneralled them by "entering Korea through a different opening in the mountains "in the forcing of which there had been 4 or 5 men killed on "both sides. The Mahrattas then entered Korea and took "possession of Mirzapur the ancient capital of the country. "Upon this the Chohans fled; the Rajah took refuge in his "fort; and the mountaineers obscured themselves, with their "families and as much of their property as they had time to "carry off, in the most impenetrable parts of the woods and "in caves among the hills and rocks. The enemy then ravaged "the country and burned the villages, which very much dis-"tressed the Rajah's subjects, whereupon they supplicated "him to make peace. A treaty was begun and concluded on "his stipulating to pay the Mahrattas 2,000 rupees and the "Mahrattas agreed to return some cattle which they had "taken. I was well informed that this sum was considered "merely in the light of a nominal tribute or acknowledgment "of submission; for the Rajput had it not in his power to pay "one rupee and the Mahrattas had agreed to let him off on his "giving them 5 small horses, 3 bullocks and a female buffalo." This Gilbertian finish to a contest in which no less than three "Rajahs" besides the Marathas were engaged is typical of the petty operations in which the native Governments were continuously involved.

Of the Marathas' treatment of the cultivating classes Blunt draws a rather dismal picture. "The Mahrattas keep "their peasantry in the most abject state of dependence by "which means they alleged the Ryots are less liable to be tur-"bulent or offensive to the Government. Coin is but sparingly "circulated among them, and they derive their habitations and "subsistence from the labour of their own hands. Their troops "who are chiefly composed of emigrants from the northern and "western parts of Hindustan are quartered upon the tenantry "(i.e the Patels) who in return for the accommodation and subsistence they offer them require their assistance whenever it "may be necessary for collecting the revenues. Such was the "state of the Government of Chhattisgarh, the exports of "which in seasons of plenty are said to employ 100,000 bullocks, and it is accordingly one of the most productive "provinces under the Berar Rajah."

92. According to Vans Agnew the Mahratta conquest was not a misfortune to the people. "Judging from the present "state of the Zamindaris into which the direct authority of the "Mahrattas has not been introduced, compared with the "Khalsa lands most of which have been under their direct "management for near 74 years, the effect produced by their "conquest of the country must be considered to have materially promoted the civilization of the inhabitants as well as "the agricultural improvement of the Lands." But this is a point of view which it is possible to challenge. I do not wish to lay stress on the confusion which arose in the later days of Mahratta rule when, in Vans Agnew's often-quoted words, the administration of the country "was one uniform scene of "plunder and oppression uninfluenced by any consideration "but that of collecting by whatever means the largest amount "possible." The prominence given to this description of the Mahratta Government in the last days of its degeneracy by British officials obviously does injustice to their system of management. On the other hand I am tempted to question the correctness of the view that Mahratta rule "promoted the "civilization of the inhabitants and the agricultural improvement of the land." So far as this statement is based, as apparently it was, on a comparison of the condition of the surviving Zamindari Estates with the condition of the lands which the Mahratttas had converted into "*Khalsa*," the inference is manifestly unfair. For it was just those remote, hilly and unproductive tracts which alone the Mahrattas were content to leave in the hands of the ancient Zamindars. Moreover in spite of their direct control and their oppressive methods the Mahrattas never seem to have got more than 4½ to 5½ lakhs of land-revenue from the country whereas the Haihayas secured 6½ to 7 lakhs of rupees according to the old *Deshbahis* in spite of the existence of intermediate chiefs of *Garhs* and *Taluqs*. Lastly, Mahratta rule was frankly despotic and openly asserted the sovereign rights of the King to all ownership of land, allowing no consideration for indigenous methods of administration, and making no concession to any local customary status. There was no give-and-take between the ruler and the ruled. The state in fact was, as Sir A. Lyall said, an organism whose sole function seemed to consist in its exercise of the powers of suction. It absorbed the wealth of

the people and gave practically nothing in return.[1] The Rajput rule on the other hand was a natural development from the tribal stage, it found a place in the indigenous administrative hierarchy for every grade of local society, it allowed for custom, and made concessions to the wishes of the people. It contributed little perhaps to their welfare but at least it did not actively interfere in the people's own arrangements for managing their own affairs. Blunt's description of the "abject state of dependence" in which the Mahrattas kept their peasantry was written only a few years after Bimbajee's death, and must, I think, be taken as a fair indictment of the Mahratta system of administration, for, as he explains, this oppressive attitude was assumed as part of a deliberate policy. The condition of the people in the old Haihaibansi days with a king restrained by the power of his Zamindars and the Zamindars influenced by the *Taluqdars* and the *Taluqdars* influenced in turn by their village Headmen, and the whole subject to the customary authority of a regular system of *Panchayats* which at any rate administered justice according to the convictions and prejudices current at the time among the mass of the people, must have been a far happier state and one consistent with far more consideration for the general and individual welfare than any system of foreign and despotic rule such as that introduced by the Mahratta conquerors.

CHAPTER X.

SUMMARY AND CONCLUSION.

93. It only remains to emphasize before I finish the main thesis which I have set myself to prove. So far as I am aware no student of the history of tenures in this part of India has accorded recognition to the essential peculiarity of the system of administration which we find existing only a century and a half ago in Chhattisgarh and the surrounding countries.

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[1] Note the following account of the progress of the mother of the Raja of Berar and his brother Venkaji Bhonsla through Chhattisgarh in 1798 on their pilgrimage to Jagannath: "We found in our subsequent progress their march imprinted by the desolation of all the small villages through which they had passed. The inhabitants had fled from the depredations of their camp followers and from the oppression of compulsory labour. This must be imputed to their attendants only; but military execution against some Zamindars of Chhattisgarh for a trivial offence and confiscations against eminent chiefs in Cuttac on a flimsy pretence were subsequent acts for which the prince himself or his royal mother must exclusively answer. In the pride of grandeur and blindness of superstition these personages have perhaps never reflected that the guilt of the oppressor must outweigh the merits of the pilgrim in the presence of the protector of the world (Jagannath)."

We may turn to the history of other Hindu States, to Tod's Rajasthan or to standard works on Orissa, but in none of them is evidence forthcoming to indicate such delegation of authority wholesale from the Rajah to his chieftains and from the chieftains to the minor chiefs as that which I have described in Ratanpur, Raipur, and Sambalpur. To find another instance of the kind we must refer, as Baden Powell tells us, "to the earliest Vedic accounts" of Aryan custom, or must wander far afield among the Assamese or Tibeto-Burman races (see para. 60 above). Yet here in Chhattisgarh we have this primitive method of social and political organization persisting up to the first half of the 18th century in a country which had been under Rajput rule for over 7 centuries. The system was so well established as to pervade a wide stretch of country outside and around Chhattisgarh. It was the only method of administration known in Bastar, Kalahandi, Sambalpur and Surguja, and it was so deeply engrained in the customs of the people that even to-day we can see clear traces of it in the Zamindari Estates, while the settlement officers of the 'sixties actually saw the organization in working order in some of the remoter parts of the Raipur and Bilaspur Districts.

94. It is hard to give an exact definition of this mediaeval polity. It was not a purely political organization, for it was rooted also in the social life of the people. It was not a purely feudal system, for it bears many traces of the tribal organization out of which it had developed. There is in fact no one term to describe it. To my mind the best idea of it is conveyed by calling it a system of feudalism superimposed on an earlier tribal organization. The feudal element was represented by the hierarchy of persons each pledged to assist his overlord in peace and war. The ryot was subject to the *Gaontia*, the *Gaontia* to the *Dao*, the *Dao* to the *Diwan* and the *Diwan* to the *Raja*. But this was only one aspect of their relationship. Feudalism has been described as the creation of a condition of affairs in which, the other bonds of society having been relaxed recourse is necessarily had to the dependence of the small upon the greater, of the weak upon the stronger. In Chhattisgarh it was far otherwise. The feudal element was imposed by the conquering Rajput, upon a pre-existing tribal system which still persisted, and persisted with great vigour, for many centuries after the authority of the Haihaibansis was established. In parts of the country it actually outlived the feudal dynasty of these Rajput kings. Being thus founded on a natural indigenous basis, the system was at first in practice and in theory always very simple and at the same time very comprehensive. Religion lent its sanctity to the authority of the various territorial authorities each in his degree ; and their control, so far as it was exercised, extended to every form of social and political activity. The

same leader who collected the ryots' rents in times of peace would lead them out to fight in times of war. The same authority which protected the village from outside attack would dispense justice within it not merely in criminal matters but in civil and domestic disputes as well.

95. Thus, though the feudal authority was there, it was always held in check by the democratic tendencies of the tribal life. The tribe, as we see so clearly in Macpherson's pages, is essentially individualistic. The patriarchs in their different grades are never more than *primus inter pares*. Their authority is trammelled at every turn by custom and by the system of Panchayats. Their personal authority apart from the religious sanctity surrounding their position is very small. They are the pivots on which the system turns rather than the motive power which keeps it going They are no more than elders among other elders who form an executive council so to speak for the disposal of ordinary business, all measures of extraordinary importance being laid before an assembly of the whole tribe. Now much of this democratic element seems in Chhattisgarh to have coloured the whole fabric of government throughout the period of Rajput rule. As has already been pointed out the very fact that each authority from the Raja downwards was content with a very limited sphere of direct control shows what regard they felt themselves compelled to show to every grade of society below them. Clearly there was some adjustment of political forces, some balance of political power, which limited all personal authority, a limitation of which the only explanation is to be found in the strength of tribal feeling.

96. We find in fact in Chhattisgarh, as Sir A. Lyall found in the Rajputana states, the embryonic beginnings of constitutional rule. As the natural tribal life of the people broke up before the stream of immigrants, foreigners from Hindustan were introduced by the Haihaibansis as local chiefs and minor chiefs. But the system absorbed them, as is evident from the fact that the mixed tribal and feudal organization lasted till the end of the Rajput rule. Had the organization possessed any solid powers of self-defence against external attack it might have survived long enough to evolve some political system less barren than that of the ordinary oriental despotism of Mogul and Maratha. But this half-formed organism—its growth stunted by the extraordinary seclusion in which it had developed—had no means wherewith to cope with a foreign invasion and its frame-work was shattered at once and irretrievably when the Marathas over-ran the country.

97. We can therefore study the mediaeval organization of Chhattisgarh merely as an antiquarian curiosity. It was up till 1745 A.D. the logical outcome of the different social and political forces which from time to time were brought to bear upon the country. But the Maratha conquest swept it out of existence

as a system, and superimposed a centralized organization (which we in our turn have maintained and strengthened) having practically no political relation whatsoever with that for which it was substituted. We must be content then to examine these fossil remains of mediaeval Chhattisgarh, reconstruct the skeleton as far as possible, and give it its proper place in the museum of bygone political phenomena. Historically it seems to me that this political formation is of a very early date. It represents the first compromise between the tribal life and the monarchy by conquest. And is logically not only prior to the more centralized system of the ordinary mediaeval Hindu state but anterior even to some of the Dravidian kingdoms, e.g. Deogarh and Chanda, which preceded the Maratha conquest in other parts of what is now known as the Central Provinces.

98. The Hindu and certain of the later Gond kingdoms comprised an extensive territory under the king's control which was administered by the king's *officials*. This *khalsa* formed "the central and usually the richest part of the country" while the subordinate chiefs were relegated to the outlying tracts around it. This is the typical mediaeval Hindu kingdom (Baden Powell's Village Community, pp. 195-197). Thus of the old Hindu kingdom of Orissa we read that "the whole country was divided, exclusive of the vast tracts held in jaghir tenure into "numerous circles or allotments afterwards the *Pergunnahs* of "the Moguls. Each of these petty districts was managed by "2 classes of *officers*, the one had the chief superintendence "and direction of affairs and conducted the Police duties with "the aid of an officer called the *Khundait*; and the other was "an accountant, who superintended more immediately the collection of the revenue, drew out the accounts of produce and "cultivation and kept a Register of all the particulars of "the lands."

"There were besides these common revenue and police "officers, the great military Jagheerdars styled Maha Naik, "Sawunt, Khandait, Bhooputees and more commonly Bhooyan "who held, as hereditary fiefs, the mountainous and wood land "tracts on either frontier with some portion of the open plains "and likewise the ministers and servants of the Rajah, the "Bewurta, Senaputtee Raee Gooroo, etc., who derived their "emoluments from extensive grants of unassessed lands.

"The above was the state of affairs found by Rajah Jye "Singh, the General of Akber and Tooder Mull or as the "Ooriahs call him Toorul Mull who came to make the settlement of the Province somewhere about A.D. 1580." (Stirling's Minute of October 10th, 1821, on Tenures in Orissa, p. viii).

Similarly the Gond Administration, as described by Major Lucie Smith in Chapter VII of his Settlement Report on the Chanda District, divided the *Khalsa* of the Chanda kingdom into 33 Parganahs; and the Parganah *officials* consisted of a *Killedar* or *Diwan*, *Deshmukh*, a *Deshpandia* and *Sir Mukaddam*. These were "entrusted with the duty of extending cultivation "in the Parganah, watching that no villages fell to waste and "making the yearly settlements. The Deshmukh was first in "rank and probably exercised a control over the other two." Outside the Khalsa were the feudal estates of the chieftains who are now known as Zamindars.

99. Chhattisgarh presents a striking contrast to these other types of mediaeval rule in so far as there are no indications throughout the length and breadth of the country of the existence prior to the Maratha conquest of any official class. We read of *Budkars* or Revenue peons, but they were employed within the *Garh* by the Zamindar or Diwan. The only other "official" to whose existence in Haihaibansi times any reference is made is the *Panj*, whose functions have been described in para. 86 above and who was obviously a survival of the tribal period rather than a creation of the central power. The whole administration of Chhattisgarh was carried on by hereditary Chieftains in charge of *Garhs* and *Taluqs* who regulated the village communities within their boundaries. Their position was stabilized because it was not only recognized by an overlord but was also accepted by the mass of the people and by the hierarchy of subordinates who were included in the area of their control. They were not owners of their estates, for they were subject on all sides to customary restrictions; and they were certainly not officials, for their tenure was hereditary. Though originally accepted by their overlord the family claimed its position more by virtue of its authority among the people than by virtue of any appointment by the king. This absence of an official class was an essential feature of the local system, and thoroughly characteristic of the mixed tribal and feudal organization which I have attempted to describe.

That there was no official class is placed beyond doubt, firstly, by the absence of any tradition or record of their existence in Haihaibansi times, and secondly by Major Vans Agnew's specific statement that "Under the Haihaibansi "Rajah the feudal principles of their rule *precluded* anything in "the nature of a system of revenue."

100. Let us contrast what we have seen here with what Sir W. Hunter tells us of the history of tenures in Orissa (Orissa, Volume II, page 214): "Under the Hindu dynasties the land "arrangements in our three Districts of Orissa proper closely "resembled the system still current in the Tributary States. "The ownership rested in the sovereign; the right of occupancy in the village community or in the individual "tiller of the soil. *The Hindu Princes allowed no intermediate tenures* or proprietary rights to grow up between "themselves and the actual cultivator but treated their

"kingdom as a private estate and vigilantly administered "it by means of land bailiffs and a *great staff of subordinate "officers.* The Muhammadan conquerors found this arrange-"ment impracticable. The Hindu plan involved more scru-"tiny and local knowledge than was possible with a non-resi-"dent prince, and the distant Emperors in Northern India "administered less by officers than by intermediate proprie-"tors between themselves and the cultivators. That is to "say, the *land stewards who under the close watching of a resi-"dent Hindu Prince were only public servants* acquired under "the Musalmans a fixity of office and an independence which "prepared the way for their development into landed pro-"prietors. This last part of the process has taken place under "British rule. The growth of proprietary rights in Orissa "therefore divides itself into three stages; the Era of offices "under the native Hindu Dynasties; a period of inchoate "Rights under the Muhammadan conquerors and the age of "Landlords under the English reign of law.

101. The Polity of Chhattisgarh was the absolute antithesis of that under the Hindu dynasties of Orissa. So far from the Rajput kings of Ratanpur and Raipur dispensing with intermediaries between themselves and the cultivators of the soil they adopted and deliberately developed the tribal hierarchy of village headmen, chieftains of the *Taluq* or *Barhon* and Lords of the *Garh* or *Chaurasi*, each of whom exercised the widest powers within his own sphere of action while the king remained a figurehead, little more than one of his own "Subordinate Chiefs." And this system prevailed right down to the end of Haihaibansi rule. It was the destruction of the greater Lords or Zamindars by the Marathas and the expulsion by the first British administrators of the Maratha *Patels* who had slipped into the place of the old *Taluqdars* which, for the first time in the history of Chhattisgarh, brought the village headman into direct relations with the rulers of the country. And it is this which led to the grant to village headman of proprietary rights in their villages at the "thirty years settlement" of 1869.

102. It is for others to decide how far the political system of mediaeval Chhattisgarh which I have described was peculiar to this part of India. I have neither the knowledge nor the experience necessary to form an opinion on the point. But I believe that the opportunity it offers for the exmination of an early form of indigenous rule is probably unique.

Conclusion.

It is indeed a curious circumstance that the outlines of this primitive organization should have persisted so long amid the social and political ebb and flow which was for centuries undermining it prior to the establishment of Maratha rule in the middle of the

18th century. And there is something very tantalizing in the way in which accident has deprived us of every written record of what was a living political organism less than 200 years ago, leaving no more than scattered references from which to reconstruct the story of these early kingdoms. I am certain, however, that methodical research will disclose much further information in the light of which my view—that a system of devolution of authority based on the tribal origin of the territorial sub-divisions in Chhattisgarh persisted throughout the period of Rajput rule—can be put to a final test. What I have written here is the result of no more than casual enquiries and desultory reading. What is needed is a careful study of the survivals in other parts of the country; and, more particularly, in the Native States none of which has, I believe, been yet examined from this point of view. My own efforts will be far more than repaid if this, I fear, rather inconsequent contribution to the annals of an obscure locality stimulates enquiry into the mediaeval history of the petty kingdoms in and around "the country of the Thirty-six Forts."

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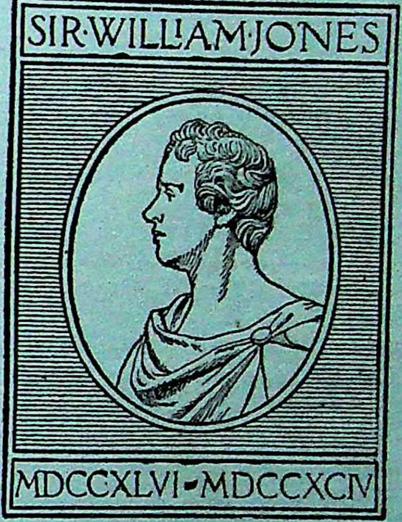
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14. Interaction of phosphorus halides and arsenious and arsenic compounds.

By NAGENDRA NATH SEN, M.Sc.

A Michaelis has shown that phosphorous chloride and arsenious oxide react in the dry state according to the equation $5As_2O_3 + 6PCl_3 = 4As + 3P_2O_5 + 6AsCl_3$ and that phosphorous chloride and arsenic oxide appear not to react even at 200°. (Zeitschr. f. Chem. (2) vii, 151, from Jenaische Zeitschr. vi, 240).

But a very interesting and curious reaction takes place when phosphorous halides, viz. phosphorus tri-chloride, phosphorus tri-bromide and phosphorus tri-iodide are added to an aqueous solution of arsenious oxide. When a few drops of phosphorus tri-chloride are added to an aqueous solution of arsenious oxide the solution slowly turns yellow, then opaque brown and finally a copious precipitation of a dark brown substance takes place. This substance has been analysed and found to be pure elementary arsenic. During the reaction a vigorous evolution of heat and hydrochloric acid fumes occurs. Phosphorus tri-chloride is, as is well known, hydrolysed by water into phosphorous acid and hydrochloric acid. At first sight it might appear that the reduction of arsenic compounds in these instances is effected by the phosphorous acid produced from the hydrolysis of phosphorus tri-chloride. Experiments were, therefore. performed with pure free phosphorous acid solution and an aqueous solution of arsenic tri-oxide in presence or absence of hydrochloric acid. But no reduction to metallic arsenic was observed however long the mixture might be preserved at temperatures varying from 0°C to the boiling point of the solution. With phosphorus tri-chloride also previously dissolved in water whether at 0°C or at room temperature no reduction takes place even on boiling.

With phosphorus tri-bromide and phosphorus tri-iodide the same reactions take place with certain special characteristics. The reaction is slower when phosphorus tri-bromide or phosphorus tri-iodide is directly added to arsenious oxide solution; the latter turns yellowish brown and the colour gradually deepens to red brown; after shaking for some time slow precipitation of arsenic takes place which is hastened by boiling, when the solution becomes clear and colourless. With phosphorus tri-bromide the precipitate is pure and brown in colour, but with phosphorus tri-iodide it is red brown and contaminated with traces of red phosphorus, probably resulting from the decomposition of phosphorous iodide by water; phosphorus, being in a colloidal state in the solution of its iodide, cannot be removed by filtration.

Strangely enough if phosphorus tri-bromide or phosphorus tri-iodide be previously dissolved in water at the room temperature to form a colourless solution and then mixed with arsenious acid solution, the reduction to metallic arsenic occurs in the same way but with less activity. If these solutions be prepared at 0°C and then allowed to react with arsenious oxide solution the activity appears greater, phosphorous iodide solution being more reactive than the bromide. But they completely lose their reactivity if boiled before the addition of arsenious oxide solution. The activity also diminishes when the solutions are kept for a long time at the ordinary temperature.

Phosphorus di-iodide behaves exactly in the same manner as phosphorus tri-iodide, with this difference that some red phosphorus is simultanteously precipitated; when previously dissolved in water and filtered from the precipitated red phosphorus the solution behaves just like that of phosphorus tri-iodide.

The reaction is very delicate. Indeed, with phosphorus tri-chloride the presence of arsenic can be detected definitely in a solution of arsenious oxide containing only ·000075 grams of arsenic per c.c.

The reductions have been observed with solutions of arsenites and arseniates with and without the introduction of any free acid. In the presence of an excess of an alkali the reaction is retarded and almost no appreciable precipitation of arsenic occurs. From this it appears that the presence of hydrion is an essential condition for the occurrence of the reaction. When no additional hydrochloric acid is introduced the hydrions are provided by the hydrochloric acid and phosphorous acid resulting from the hydrolysis of the phosphorous halides.

No reaction however takes place between dry arsenious tri-chloride and phosphorous tri-chloride when kept in a sealed tube for a long time, but as soon as atmospheric moisture is admitted slow precipitation of brown arsenic takes place. This confirms the view that the presence of hydrion is necessary for the reaction.

[Hypophosphorous acid and hypophosphites, though more powerful reducing agents than phosphorous acid and phosphites, are, curiously enough, without any action upon the arsenic compounds.]

It has also been observed that antimonious and antimonic compounds are not affected at all by these reagents and therefore the reaction can be employed as a test for distinguishing arsenic from antimony.

Both the brownish black and reddish brown arsenic obtained as above are amorphous and insoluble in carbon disulphide. They appear to be new allotropic modifications of arsenic, a further examination of which is intended. In all cases, specially with phosphorus tri-iodide, arsenic is in a colloidal state before it is precipitated. This colloidal solution of arsenic when dilute can be preserved unchanged for days. The preparation of pure colloidal arsenic by this method is in view and may be of physiological importance

The reaction seems to take place according to the following equation :—$As_2O_3 + 3PCl_3 + 9H_2O = 2As + 3H_2PO_4 + 9HCl$.

Phosphoric acid has been detected in the filtrate. It appears that the reaction proceeds to completion if excess of phosphorus tri-chloride be maintained in the system. In an actual experiment 59·1% of the arsenic content of the solution was precipitated by a single addition of phosphorus tri-chloride and the filtrate on treatment with more phosphorus tri-chloride gave a further precipitation of metallic arsenic. With phosphorus tri-bromide and phosphorus tri-iodide it has been mentioned that the reaction occurs with an appreciable velocity even when they are previously dissolved in water ; from this as well as from the fact that free phosphorous acid, even when freshly prepared, is without any action on arsenious oxide, it seems probable that an intermediate compound, which in the case of phosphorus tri-chloride is very unstable, slightly stable in the case of the bromide and appreciably stable in the care of the iodide, is responsible for the reaction. The nature of this intermediate compound cannot be established without further investigation, specially from a physico-chemical point of view. Suggestions may be made of an intermediate compound like $PX_3.3H_2O$, which during its conversion into phosphorus acid reduces the arsenic compound : or in other words phosphorus acid at the moment of its formation is in a more reactive state. If this view proves to be true, this behaviour of a compound molecule may be likened to the nascent state of an element.

In connection herewith reference may be made to a paper by R. G. Durrant on the interaction of stannous chloride and arsenious chloride (Trans. Chem. Soc., 1919, 115 & 116, 134) which was first noticed by A. Bettendorf (Sitzungsber. Neiderrhein. Ges. Bonn, 1869, 128). The arsenic obtained by the authors by reduction with stannous chloride is buff brown and soluble in carbon disulphide and never free from tin. This evidently differs from the arsenic as precipitated above with phosphorous halides.

My best thanks are due to Prof. Sir. P. C. Ray for his kind encouragement and advice.

15. Notes on the Vegetation of Seistan.

By N. ANNANDALE, D.Sc., F.A.S.B., *Director, Zoological Survey of India*; and H. G. CARTER, M.B.CH.B., *Economic Botanist to the Botanical Survey of India.*

[With plates V—VIII.]

PREFATORY NOTE.

When two authors collaborate on a scientific paper with different kinds of knowledge, it is as well to make clear what share each has had in the work. In this paper Dr. H. G. Carter is responsible for all taxonomic and phytogeographical statements, while I have added notes made in the field, with summaries thereof and certain deductions therefrom. Dr. Carter is a systematic botanist, which I am not; but I have been to Seistan, and Dr. Carter has not. Perhaps some apology will be expected from a zoologist who has ventured to discuss the ecology of plants, but it often seems to me that in biology much of value is apt to be left unrecorded because the professional observer considers what he observes too trivial for mention in print.

The specimens on which this paper is mainly based were collected in Seistan and on the Persian frontier of Afghanistan and Baluchistan in November and December 1918 by myself. A large proportion of them are from Lab-i-Baring on the edge of the Hamun-i-Helmand, a place within easy reach of several different types of vegetation, notably that of the stony desert, that of the margin of saline streams, and that of the Seistan lake-system. Others are from Hurmuk[1] in the stony desert on the Afghan-Baluch frontier, and others again, only a few, from the alluvial plain of Seistan. It is from this last district that the fodder plants collected by Major Thomas probably came.

The vernacular names were taken down on the spot either by natives of Seistan or by Indians well acquainted with the Persian language. I can claim no knowledge of this language myself and any comments on the names are due to Dr. Carter.

N. ANNANDALE.

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[1] It is disputed whether this place falls within the boundaries of Seistan or not

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INTRODUCTION.

Seistan is one of the most easterly and at the same time perhaps the most isolated of the districts of Persia, lying just north of the point at which Persia, Afghanistan and Baluchistan meet. It has been described as an oasis in the desert, but any country more unlike the conventional idea of an oasis—an island of herbage and palm-trees in a sea of yellow sand—it would be hard to imagine ; for it is an undulating plain (or rather low plateau, less than 2,000 feet above sea-level) of stiff grey clay, almost bare to the eye in winter, containing a large lake of almost fresh water and surrounded by black stony desert. It is in fact the inland delta of the Helmand river and the basin into which that river drains The Helmand has escaped the fate of most bodies of water in Persia—that of desiccation or salinity—by reason of the fact that it runs for the greater part of its course, before debouching on the great desert of Afghanistan, through the mountains, whence it receives many tributaries. Its waters are fresh, but the soil of the basin into which they flow is impregnated with soluble mineral salts. These they naturally dissolve and the solution rises through the soil by capillary action, forming a kind of cement which is very infertile and has to be removed before any kind of agriculture becomes possible. When this has been done the soil becomes fertile, and yields two crops of barley a year. Many of the streams are, however, so saline that the salts crystallize at their margin.

We can thus distinguish in Seistan several very distinct types of environment, and therefore of vegetation. There are the vegetation of the stony desert, that of the alluvial clay, an almost normal lacustrine vegetation and a highly specialized halophytic one. There is also in some parts of the country a sand-dune vegetation. All these different types of vegetation are represented in the collection under consideration, but all not equally well, for there was comparatively little opportunity of investigating the plants that grew on alluvial clay or on sand-dunes. Moreover, the most fertile part of the country, which lies in the immediate vicinity of the large effluents of the Helmand, was not visited. Our account of the vegetation of Seistan must therefore be a partial one, and it must be further remembered that the collection was made in the depth of winter, when the temperature sank well below freezing-point almost every night.

This latter point, however, is perhaps less important in Seistan than it would be in most countries, for the little rain that falls (slightly over 2½ inches a year) commences to do so about the end of December, just after the period of our visit, and practically completes its tale by April.

The agriculture of the country depends rather on the floods of the Helmand, due to rain and the melting of the snows in Afghanistan, than on the local rainfall; but the desert plants are little affected by the floods and prepare their seeds in anticipation of the showers. In the desert we found most of the larger plants, probably for this reason, in fruit, and a considerable proportion still in flower.

Botanical collections made in Seistan are of value as this locality has been seldom visited by Indian botanists. Boissier's *Flora Orientalis* is perhaps the only important work that deals with the descriptive botany of the entire region lying west of India. The type of vegetation there is quite distinct from the Indian, and by this opportunity we have obtained several plants not represented before in Indian Herbaria.

As in most desert areas, the most characteristic feature of the plants lies in the large number of Chenopodiaceae. The attempt therefore to place the results on a systematic basis may not be without some interest. The lists are arranged according to Engler and Prantl's classification adopted in their *Pflanzenfamilien*. There are altogether 25 families, 50 genera and 70 species discussed. References have been added to Boissier's work, Hooker's *Flora of British India* and sometimes to Muschler's *Flora of Egypt*.

ABBREVIATIONS USED.

Boiss. Fl. Or.	..	Flora Orientalis by Edmond Boissier.
D'C. Prodr.	..	De Caudolle's Prodromus Vegetabilis.
Fl. Br. Ind.	..	Flora of British India by Sir Joseph Hooker.
Musch. Fl. Egypt	..	Flora of Egypt by Dr. Reno Muschler.

I. THE VEGETATION OF THE STONY DESERT.

The desert[1] that surrounds Seistan to the south and west is composed of scanty soil full of black pebbles. It contains a few widely scattered springs, the water of which is usually more or less saline, and numerous dry river-beds, filled very rarely by torrents of water due to storms. Plants were collected at two places in the desert, at Hurmuk in the south-east and at Lab-i-Baring in the west. As Hurmuk is supplied by a copious spring of fresh water which forms a small rivulet, it is perhaps a less typical desert locality than Lab-i-Baring, where the water (which is abundantly present) is confined to the bed of the Hamun, and considerable differences may be noted in vegetation, though in both places the influence of the water on plant-life is restricted to its immediate vicinity and the soil a few yards from it is apparently as dry and as barren as it is a mile distant. Our remarks refer mainly, so far as the desert vegetation is concerned, to Lab-i-Baring, where a much larger collection was made.

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[1] For an account of the great desert of which it is a part see Vredenburg, *Mem. Geolg. Surv. India*, Vol XXXI.

At this place the dominant family in the desert vegetation is undoubtedly the Chenopodiaceae and the dominant genus *Salsola*. It is, therefore, particularly unfortunate that the species of this genus cannot be identified completely owing to lack of material for comparison in Calcutta.

Though possessing for the most part extremely thick stems few of the plants of this vegetation are large enough to be called shrubs. In addition to woody stems they have extremely long tap-roots and also long lateral roots spreading out in a circle round the base of the tap-root and covering a considerable area superficially. This habit is found in all families except the grasses. The plant in most cases belongs to one of two types. It either forms an extremely dense bushy mass or else lies quite flat on the ground with the branches entirely horizontal at right angles to the tap-root. Most of the species of *Salsola* belong to the former type, of which *Launaea spinosa* is a particularly good example. In this species the branches are intertwined in a complex pattern, but in many others (*e.g. Moricandia sinaica*) they grow upright and produce a switch-like mass. Of the type of plant with flat horizontal branches good examples are *Euphorbia granulata*, the local form of *Cressa cretica* and *Schweinfurthia spherocarpa*. The two former species have very small leaves closely pressed together, while those of the last are comparatively large, fleshy, broad and spreading, Forms intermediate between the two types of habit are not uncommon, for example *Fagonia Bruguieri*, the main branches of which are entirely horizontal, but send up short spiny twigs in such a way that the plant is sometimes almost globular, and *Heliotropium arbainense*, the flat but dense tufts of which have quite an alpine appearance. The grasses of the desert also form almost flat dense tufts, but their inflorescence grows upright. Only two species were collected, in one of which (*Aristida plumosa*) the inflorescence is very delicate and grows on a slender stem, while in the other (*Æluropus villosus*) the flower-stem. and indeed the whole plant, is dwarfed. We will refer to the latter species again in discussing other types of vegetation.

The leaves of most of the plants are very small, but the terminal twigs in a large proportion of the species (*e.g.* in most of those of *Salsola*) are swollen and fleshy. No plant was seen in which the main stem was of this nature. In a few species the leaves are broad and flat (*e.g. Schweinfurthia sphaerocarpa*), while in several they are fairly large, thin and leathery. The best examples are Ruta sp and the Colocynth. In a few species the whole plant is thin and dry and has a remarkably withered appearance. This is most conspicuous in *Salsola foetida* and *Halogeton ? glomeratus*, in both of which the plant appears to be not only dead but bleached, and the only external sign of life is to be found in the green tinge that may be noted on the lower surface of the base of the twigs

Spines or thorns occur on a large proportion of the plants in this vegetation, but they are not all of the same nature. Those of *Astragalus gerensis*, which are particularly long, strong and sharp and form dense radiating spheres or hemispheres protecting the fruit, are produced by a modification of the rachis of the leaves. When the leaf is young the rachis is green and tender. but it gradually hardens, the leaflets drop off and it is transformed into a remarkably formidable weapon of defence.

In this plant, as in several others, the flowers are situated only at the base of the leaves or on the lower surface of the branches, which spread out horizontally, protecting the flowers and seed from destruction by wind and perhaps assisting in fertilization by insects, which are by no means uncommon under the shelter of such plants in the desert. Other examples of the same phenomenon are *Tribulus alatus* and *Andrachne telephioides*. In the former the flowers are relatively large and conspicuous, while in the latter they are small; but in both plants they are situated along the main branches and directed downwards. The Euphorbiid can thus be distinguished at a glance from its somewhat similar relative *Euphorbia granulata*, in which the flowers are on the upper surface of the branches and directed upwards.

The winds of Seistan are particularly violent and usually blow from the north-west. Protection against them is one of the chief needs of the desert plants, and this is provided for largely by the devices already noted. Its necessity is shown by the fact that it is only on the leeward side of little hills in the desert that there is any vegetation at all, and that plants are far more abundant in hollows than on the level, though there can seldom be any particular moisture in the former.

Both at Lab-i-Baring and at Hurmuk most plants are in danger of destruction from grazing camels, against which thorns are a very poor safeguard. The stout woody stems and roots[1] are a much better guarantee for the survival of the species, for those not only prevent the plants from being blown away or broken in fragments but also preserve their vitality and enable them to sprout again after their soft parts have been eaten. The thorns are probably a protection rather against small desert rodents, phytophagous lizards (*Uromastix*) and possibly birds, than against camels. Against the larger vertebrate enemies the very inconspicuous appearance of the vegetation of the stony desert is possibly an additional protection. At first sight one might imagine that the gravel round Lab-i-Baring was absolutely barren, although, as the lists given in this paper prove, it really has a fairly rich and varied vegetation. Very few of the plants are of conspicuous colouration, the leaves and young stems being mostly of a dull glaucous shade and the flowers small and greenish. One of the commonest species (*Euphorbia granulata*), however, exhibits a curious variation in this respect, some plants having the leaves varying in colour from dull pink to dull green, while in others they are all bright leaf-green. This variation is not correlated in any way with environment, for plants of the two colour-forms were found actually interdigitating in such a way as to appear to form a single flat clump.

The most conspicuous plants noted at Lab-i-Baring were a species of Artemisia with an orange-brown inflorescence and pale glaucous grey leaves, and a Ruta which has yellowish leaves and flowers. The small white flowers of *Heliotropium arbainense* are also fairly conspicuous, and so also is the whole plant in *Salsola foetida*, and *Halogeton? glomeratus*, which are white and shining almost like a coral, and have star-like winged fruits varying in colour from scarlet to black.

The curious winged fruits of other species of Salsola appear, if examined singly, to be most conspicuous, having exactly the general form of small flowers and being as a rule of some colour between straw-colour, orange yellow and deep scarlet. Moreover, these fruits are produced in very great profusion, often almost concealing the rest of the plant. Nevertheless, in their natural surroundings they are not conspicuous, for the different shades harmonize in such a way that their essential brightness is hardly visible. In at least one species of the same family (*Anabasis setifera*) a stony desert form can be distinguished in which the whole plant is of an inconspicuous dull green colour, whereas another form, which grows among the bare clay hills (very little frequented by any kind of animal) that skirt the desert at certain places, the whole plant has a golden yellow shade that renders it most conspicuous against the dull grey clay.

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[1] Woody plants in the desert are often completely destroyed by Termites (*Hodotermes? vagans*). but are probably not attacked by the insects till dead. We have to thank Prof. Silvestri for examining specimens

It is noteworthy, further, that two of the most conspicuous plants of the stony desert at Lab-i-Baring (the Artemisia and the Ruta) are by far the most odoriferous, strong odours being the exception rather than the rule in this vegetation. The specific name of *Salsola foetida* would seem to indicate that it also has a strong scent, but this was not observed in the Seistan plant. The tempting-looking melon-like fruit of the Colocynth (the main function of which is to be blown along the desert till it bursts and scatters the seeds) is also a most conspicuous object in the desert, but is not to be eaten with impunity. Conspicuous colouration, therefore, seems to be correlated in several instances with other properties deleterious or unpleasant to vertebrates.

The vegetation which has the above-described characters is the permanent vegetation of the desert, which flourishes at all seasons, even in the depth of winter; but it must be remembered that our observations were made at that season. There is evidently in the stony desert of Seistan a short-lived spring or summer vegetation of very small plants, represented in winter-time mainly by the remains of stems, seed-vessels and the like. Such remains were particularly abundant at Hurmuk, less so at Lab-i-Baring.

II. The Vegetation of the Banks of Saline Streams.

At certain places there are on the edge of the Hamun-i-Helmand, the lake of Seistan, high cliffs formed of stiff clay impregnated with mineral salts.[1] These cliffs are breached by narrow gullies down which run little streamlets of water so saline that the salts it contains frequently crystallize out on the bank and render the soil crisp and brittle. The plants that grow commonly in soil of this description are:—

Tamarix stricta, Boiss,
Halostachys caspica, C.A. Mey,
Halocnemum strobilaceum, Bieb.,
Aeluropus villosus, Trin.,

and a species of *Salsola* with peculiarly tomentose stems and leaves.

Where the water is a little more abundant, *Juncus maritimus*, Linn. and *Phragmites? communis*, Trin. grow also at its edge.

The tamarisk is by no means confined to such spots or to soil so full of salt, but it flourishes greatly in the gullies, forming with *Halostachys caspica* small thickets, in which the bright green colour of the latter contrasts with its own grey foliage. Both these plants here attain the dimensions of large shrubs and both were found in flower in December, though this was not the case with the tamarisk in other situations. The *Halocnemum* on the contrary, which was also in flower, has a brownish colour and grows close to the ground in a way which recalls the growth of heather. while the *Salsola* forms small isolated clumps, each of which as a rule consists of a single plant. The *Juncus* is small and often has masses of salt adhering to its stems.

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[1] An analysis of water from one of the streamlets near Lab-i-Baring shows that it contains 10·683% of sodium chloride and 2·4476% of magnesium oxide.

It is the *Æluropus* and the *Phragmites*, however, that have the greatest ecological interest in this association, for the plants of both differ, though in diverse manners, from those growing in the same neighbourhood in different types of environment. It has already been noted that *Æluropus villosus* is found in the stony desert at Lab-i-Baring, but plants from the two situations, less than a mile apart, differ exceedingly, those from the gullies being much more vigorous, growing considerably taller and above all having the leaves extremely stiff, sharp and upright, forming, indeed. bayonet-like spikes. The same peculiarity of the leaves is found in the reed but in it the whole plant is dwarfed, less than a quarter the size of the *Phragmites*, unquestionably the same species, that forms the beds of the *naizar* or reed-country of the edge of the Hamun. Not only is the whole plant dwarfed, but the inflorescence is even smaller in proportion than that of the normal variety, of which it has hardly one-tenth the dimensions, and the individual flowers are also abnormally small. While, therefore, in one species of grass, which is normally a desert species probably immune to salt, the dampness of the situation has proved a stimulant, in another, accustomed to damp but not to excessive salinity, the salt has acted as inhibitive of growth. The two species have, however, developed one peculiarity in common, namely the production of stiff spiky leaves.

Probably the seasons have less effect on this holoplytic vegetation than they have even on that of the stony desert.

III. THE VEGETATION OF THE ALLUVIUM.

Fewer observations were made on this vegetation than on that of the stony desert, but greater variability was observed. In the neighbourhood of Nasratabad or Shahr-i-Seistan, the capital of the district, the land is mostly either cultivated or fallow, being irrigated by means of a network of channels issuing from the Helmand. In fallow land, at any rate in winter, the dominant, often the only plant—and it is mostly dead—is the camelthorn (*Alhagi camelorum*). In other places a dwarfed form of *Prosopis spicigera* is abundant, but there are areas in which the cement-like surface is absolutely barren. Further south, near Lutak, the vegetation is more varied and several fodder-plants are abundant, including *dhub* grass (*Cynodon dactylon*), which attains an unusually luxuriant growth. Here, and also to some extent round Nasratabad, a still more important fodder plant is a species of *Suaeda*, which is dried into a kind of hay and stacked with camelthorn for winter consumption.

Yet further south, as one approaches the Shelagh river, the clay supports a vegetation of sparse scrub consisting mainly of more or less widely scattered Chenopodiaceous bushes. This flora is hardly represented in our collection, but *Suaeda* is one of the most abundant if not the dominant genus. In this region there are many flat basins in which the clay is particularly hard and smooth. Some of these are quite barren, at any rate in winter, but others are covered with a sparse growth of the grass *Æluropus villosus*, the plants of which are intermediate between those of the stony desert and those of the banks of saline streams, being larger and taller than those of the former type of environment but not possessing the spiky leaves of those of the latter.

Still further south, between the Shelagh river and Hurmuk, in soil composed mainly of alluvial clay but containing scattered pebbles, there are what may almost be described as open woods of *Haloxylon salicornicum*, which has the dimensions of a small tree.

This plant, which we did not observe elsewhere, was the only one that could be called even by a courtesy a tree we saw growing in absolutely natural conditions in Seistan. In the neighbourhood of Nasratabad there is a shrine, the tomb of a saint, where there are trees of a species of Tamarisk of much larger size, but these grow close to an artificial water-channel and are carefully protected, as it is believed that any one who breaks a branch will lose a member of his family. Water-channels in this district are often fringed with *Salix acmophylla*, and *Populus euphratica* is common in gardens, in which apricots and occasionally date-palms are also to be found.

Here again, it must be remembered in considering what we say about the vegetation of the alluvium of Seistan, that our observations were made in winter. In spring the country is said to be green.

IV. THE VEGETATION OF SAND DUNES.

The vegetation of sand dunes, in those parts of Seistan visited, is a very poor one. In many places it consists exclusively of *Tamarix stricta*, the essentials for the flourishing of which are a friable soil, abundant subsoil water (salt or fresh), protection from wind and remoteness from human habitations.

The greater part of the fuel used in the country is derived from its stems and roots and it is cut down remorselessly when near villages or encampments. When exposed to wind it is often blown almost flat and each plant is situated on a small sand-hill, with an accumulation under its leaward side of fragments of twigs and free salt, which is secreted by it in considerable amounts. In its shelter there is usually a fairly abundant insect population. Where conditions are favourable, however, the plants form upright bushes, sometimes almost small trees, and are situated so close together that it is difficult to pass between them without touching. In some parts of Seistan the dominant plant in sand-dunes is *Peganum harmaea*, round which small dunes are rapidly formed, the long trailing branches of the plant growing out on the leaward side. This plant also grows in the stony desert, but much less luxuriantly.

In the extreme south of Seistan the sand-dune vegetation is probably richer than it is further north, but as we hurried through the former region in motor lorries, we had little opportunity of making any but the most general observations on the flora. At some places, where there is surface water, the dunes are covered with coarse grass.

V. THE VEGETATION OF THE HAMUN-I-HELMAND.

One of the most interesting features of Seistan from both a geographical and a biological point of view is the Hamun-i-Helmand. This is the basin, or rather series of basins, into which the waters of the Helmand drain. The northern basin contains a practically permanent lake of almost fresh water; the southern basins are usually dry or hold comparatively small bodies of brackish water. In floods, derived mainly from the rainfall and snows of Afghanistan, the water of the northern basin overflows into the southern ones and thence through the Shelagh river, which is usually a dry bed with occasional pools of extremely salt water, into the Gaud-i-Zirreh, an immense shallow basin almost filled with salt that lies in the west of the Afghan desert.

The Hamun is surrounded by reed-beds that cover hundreds of square miles. The outer parts of these beds are a phragmitetum, consisting of a reed exactly intermediate between *Phragmites communis* and *P. Karka*. It dies down more or less completely as the floods recede in summer and the remains are burnt by the Gaodar or cattle folk, in order to encourage the young growth when the floods return or because they consider the old dry stems injurious to their cattle. At the edge of the permanent lake there are, in addition to the beds of *Phragmites*, also beds of *Scirpus littoralis* and *Typha angustata*, all of which are perennial. The different species are not mixed indiscriminately and do not form zones of growth. Here also the vegetation is mainly a phragmitetum, but beds of *Typha angustata* and *Scirpus littoralis* also occur in the midst of those of *Phragmites.* The *Scirpus* is the more abundant of the two species and grows in rather shallower water than either the *Typha* or the representative of the third genus. The two latter grow to a great height, at least twelve to fifteen feet.

In some places these mingled reed-beds extend out into permanent water for several miles. They are traversed in all directions by narrow open channels said to be made by the cattle, which wade out belly-deep to feed on the young reeds. The submerged vegetation of these channels is scanty, but the roots of the *Phragmites* are often covered with filmy masses of greyish filamentous algae; *Vallisneria spiralis* (no specimens of which were actually preserved) is not uncommon, with occasional plants of *Potamogeton lucens.*

The channels, in which the water is only four or five feet deep in winter, open out occasionally into little pools only a few yards across but rather deeper and free of reeds. These are filled by dense masses of *Potamogeton pectinatus*, mingled with Characeae, *Naias major* and *Potamogeton perfoliatus*, the first-mentioned species being much more abundant than any of the others. There are also larger pools in the reed-beds, sometimes as much as a hundred yards across, but, except for a scanty growth of *Vallisneria* round the edges, these are devoid of macroscopic vegetation; the bottom consists of black and very malodorous mud. The larger pools are probably cleared by the people who live round the lake, for they are utilized in fishing and bird-catching.

Inside the reed-beds, towards the middle of the lake, there are at a few places scanty beds of *Potamogeton perfoliatus*, but the bottom of the open lake, which consists of very finely divided grey clay, is mostly bare.

The reeds, to use the word in a loose sense, of that part of the Hamun which is permanently filled with water are, as already stated, perennial, but they have not a very flourishing appearance in winter. The *Scirpus* and the *Phragmites* are in flower in December, but their inflorescences are past their best and have a very ragged look. The *Typha* has mostly shed its seeds, which blow all over the country with those of *Phragmites*, and becoming entangled with other plants, especially the dense, thorny plants of the desert, give them a peculiar filmy appearance. The submerged vegetation of the lake at this season is in an even less flourishing condition than the reeds. The cold affects *Potamogeton pectinatus* and *Vallisneria spiralis* less than it does the other plants of this vegetation, but many of the leaves of the *Vallisneria*, which was observed in flower, were dead and brown, while the tips of the shoots of *P. pectinatus*, which was fruiting on the surface, were white and decayed. Only a few living shoots of *Potamogeton perfoliatus* and still fewer recognizable fragments of *Naias major* were found.

It is interesting to compare the condition of the submerged vegetation of the Hamun in winter with that of the same plants in the hills of Baluchistan at the same season. In the Quetta and Pishin districts, at altitudes between 5,000 and 6,000 feet (*i.e.* more than 3,000 feet higher than the Hamun), various species of *Potamogeton* and *Naias*, including forms apparently identical with those observed in Seistan, were found both in November and in January in a flourishing vegetative condition. The temperature of the air in these districts is considerably lower than that of Seistan, but that of the water, most of which is derived from underground channels, appears to be decidedly warmer. The matter, on which no precise data are available, is mentioned here as one worthy of further investigation.

The most peculiar feature of the Hamun vegetation is the great extent of the reed-beds that surround it. The slight salinity of the water, which is salter in some conditions [1] than in others, probably encourages the growth of *Potamogeton pectinatus* by inhibiting that of other species, for this plant is perhaps the most adaptable of all the submerged plants of India and the neighbouring countries. It flourishes in the Chilka Lake [2] on the east coast of India in water much salter than that of the Hamun in the neighbourhood of Lab-i-Baring, to the exclusion of all other freshwater species, while in ordinary Indian freshwater lakes it is merely a comparatively unimportant member of the vegetation.

VI.—SYSTEMATIC LIST OF PLANTS COLLECTED IN SEISTAN BY DR. N. ANNANDALE

EMBRYOPHYTA ASIPHONOGAMA.

I. CHARACEAE.

1. **Chara**, Vaill.

1. **Chara**, sp

Loc.—Nasratabad (Nasirabad), Seistan, No. 16; alt. 1,650′. In water-channel in garden with *Potamogeton*.

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[1] Annandale, *Rec. Ind. Mus.* XVIII, pp. 12 and 16.

[2] Annandale and Kemp, *Mem. Ind. Mus.* Vol. V, No. 1, p. 12; Annandale, *Proc. As. Soc. Bengal*, Vol. XIV, No. 6, pp. clxix and clxx (1918).

EMBRYOPHYTA SIPHONOGAMA.

GYMNOSPERMAE.

II. GNETACEAE.

2. **Ephedra**, Linn.

2. **E. distachya,** Linn. Boiss. Fl. Or. v, 713.
E. vulgaris, Rich. Fl. Br. Ind. v, 640.
Loc.—Lab-i-Baring, No. 66; alt. 1,600′.

Distrib.—Europe, Western and Central Asia, and temperate and Alpine Himalayas.

Forms small bushes in the stony desert.

ANGIOSPERMAE.

MONOCOTYLEDONEAE.

III. TYPHACEAE.

3. **Typha,** Linn.

3. **T. angustata,** Bory et Chaub. Fl. Br. Ind. vi, 489; Boiss. Fl. Or. v, 50; Musch. Fl. Egypt, i, 10.
Loc.—Hamun, near Lab-i-Baring, No. 27.

Local name.—Tút تُوت. Eng. Reed-mace: often called bulrush.

Distrib.—Mediterranean region, North and West Asia and India.

This closely resembles the European *Typha angustifolia*, L. In Seistan it grows about 10 feet high and is used in making raft-boats (تُوتین). The leaves are used as fodder for cattle. The seeds are mixed with fine mud-plaster for masonry. The fluffy fruits blow all over the country like those of *Phragmites.*

IV. POTAMOGETONACEAE.

4. **Potamogeton,** Tournf.

4. **P. perfoliatus,** Linn. Fl. Br. Ind. vi, 566; Boiss. Fl. Or. v, 17.

Loc.—Hamun, near Lab-i-Baring, Nos 31 and 64; alt. 1,600′.

Distrib.—North temperate regions, Western Himalayas, and Australia.

Grows sparsely with *P. pectinatus*, L. Most of the plants were dead in December, but a few shoots were still green.

5. **P. lucens,** Linn. Fl. Br. Ind. vi, 567; Boiss. Fl. Or. v, 16; Musch. Fl. Egypt, i, 15.

Loc.—Lab-i-Baring, No. 46.

Distrib.—North temperate regions, Western Himalayas, and Australia.

In channels among the reed beds.

6. **P. pectinatus**, L. Fl. Br. Ind. vi, 567 ; Boiss. Fl. Or. v, 18 ; Musch. Fl. Egypt, i, 16.

Loc.—Hamun, near Lab-i-Baring. No. 29 ; alt. 1,600′.

Local name.—Gak گاک.

Distrib.—Almost cosmopolitan.

Grows in abundance in small pools in the reed-beds. Most of the plants were in seed, but fully alive.

7. **Potamogeton,** sp.

Loc.—Nasratabad, Seistan, No. 17 ; alt. 1,600′.

In water channels with *Chara*, sp.

5. **Zannichellia,** Mich.

8. **Z. palustris,** L. Fl. Br. Ind. vi, 568 ; Boiss. Fl. Or. v, 15 ; Musch. Fl. Egypt, i, 21.

Loc.—Nasratabad, Seistan, No. 18 ; alt. 1,600′.

Distrib.—Europe, N. Africa, Siberia and India. Common in Great Britain.

In small pools of very foul, stagnant water. In fruit.

V. NAIADACEAE.

6. **Naias,** Linn.

9. **N. major,** All. Fl. Br. Ind. vi, 569 ; Boiss. Fl. Or. v, 27.

Loc.—Hamun near Lab-i-Baring, No. 30 ; alt. 1,600′.

Distrib.—Europe, Asia and Africa.

Grows sparsely with *Potamogeton pectinatus*, Linn. Most of the plants were dead or moribund.

VI. GRAMINEAE.

7. **Aristida,** Linn.

10. **A. plumosa,** Linn. Fl. Br. Ind. vii, 228 ; Boiss. Fl. Or. v, 495 ; Musch. Fl. Egypt, i, 77.

Loc.—Lab-i-Baring, No. 56 ; alt. 1,600′.

Distrib.—Western Tibet, Turkistan, Persia, and N. Africa.

Forms very small clumps in the stony desert.

8. **Cynodon,** Pers.

11. **C. dactylon,** Pers. Fl. Br. Ind. vii, 288 ; Boiss. Fl. Or. v, 553 ; Musch. Fl. Egypt, i, 102.

Loc.—Lutak, No. 80.

Local name.—Riz ریز.

Distrib.—Throughout all warm countries.

Used as fodder for cattle. Grows with unusual luxuriance in the southern part of (irrigated) Seistan.

9. **Phragmites**, Trin.

12. **P. ? communis**, Trin. Fl. Br. Ind. vii, 303; Boiss. Fl. Or. v, 563; Musch. Fl. Egypt, i, 115.

Loc.—Lab-i Baring, Nos. 25 and 62; alt. 1,600′.

Local name.—Nai نی.

This plant is intermediate between the European *P. communis*, Trin, of which it has the habit and inflorescence, and the Indian *P. Karka* of which it has the short third flowering glume. Curious dwarfish plants were found at the edge of a stream of salt water.

In its large form it covers hundreds of square miles at the edge of the Hamun. The fruits borne aloft by the long silky hairs of the glumes blow all over the country and get entangled with other plants, giving them a fluffy appearance.

The Sayyād tribe uses the reeds for making houses and give the young shoots to their cattle and donkeys as fodder. The Gāodār tribe weave mats of the split stems.

10. **Æluropus**, Trin.

13. **Æ. laevis**, Trin. Fund. Agrost. 143, t. 12.

Æ. villosus, Trin. (in part). Fl. Br. Ind. vii, 333 and 334.

Æ. littoralis, Willd. Boiss. Fl. Or. v, 594.

Loc.—Hurmuk, Perso-Baluch-Afghan Frontier, No. 2; alt. 2,000′.

Distrib.—Mediterranean region, Arabia, Central Asia, and borders of India.

In a small irrigated garden.

14. **Æ. villosus**, Trin. Fl. Br. Ind. vii, 334.

Æ. villosus var. *repens*, Boiss. Fl. Or. v, 594.

Æ. repens, Desf. Musch. Fl. Egypt, i, 129.

Loc.—Lab-i-Baring, Nos. 26 and 60; and in the dried river basin between Lutak and Girdi, No. 83; alt. 1,600′–1,700′.

Local name.—Būno. بُونو

Distrib.—Punjab, Deccan, Ceylon, Afghanistan, westward to the Mediterranean and the Caspian region.

Forms small flat rosettes on dry gravel (see pp. 266, 269). In patches at the edge of small saline streams in soil covered with free salts. It sometimes grows in small tufts sufficiently close together to give the plain a yellowish appearance. It is then very dry and brittle. Eaten by cattle.

VII. Cyperaceae.

11. **Cyperus,** Linn.

15. **Cyperus,** sp.

Loc.—Hurmuk, Perso-Baluch-Afghan Frontier, No. 6; alt. 2,000′.

This, in its immature state, is rather like *Cyperus* (*Juncellus*) *laevigatus*, C. B. Cl.

In a small watercourse of fresh water.

12. **Scirpus,** Linn.

16. **S. littoralis,** Schrad. Fl. Br. Ind. vi, 659; Boiss. Fl. Or. v, 389; Musch. Fl. Egypt, i, 181.

Loc.—Hamun, near Lab-i-Baring, No. 28.

Local name.—Tazk تزک

Distrib.—West Asia, Europe, Africa and Australia. Throughout India.

A sedge growing in the lake and rising to about 6 ft. above the surface of the water. The Gāodār dry it and give it to the cattle as fodder. The cattle also wade out to graze on it.

VIII. Juncaceae.

13. **Juncus,** Linn.

17. **J. maritimus,** Lam. Fl. Br. Ind. vi, 393; Boiss. Fl. Or. v, 354; Musch. Fl. Egypt, i, 201.

Loc.—Lab-i-Baring, No. 63; alt. 1,600′.

Distrib.—From Afghanistan westward to the Atlantic, America, and Australia.

Grows in strongly saline water in close vicinity to *Æluropus*, *Halocnemum* and dwarfed *Phragmites*. Stems sometimes encrusted with salt.

DICOTYLEDONEAE.

IX. Salicaceae.

14. **Salix,** Linn.

18. **S. acmophylla,** Boiss. Fl. Br. Ind. v, 628; Boiss. Fl. Or. iv, 1183.

Loc.—Nasratabad (Nasirabad), Seistan, No 15; alt. 1,600′.

Local name.—Bed, Bīd بید. Eng. Willow.

Distrib.—North-western India, Afghanistan, Baluchistan, and westward to Syria.

One of the commonest cultivated trees in the country. It never reaches a large size, and usually grows along watercourses.

15. **Populus**, Linn.

19. **P. euphratica**, Oliv. Fl. Br. Ind. v, 638; Boiss. Fl. Or. iv, 1194; Musch. Fl. Egypt, i, 243.

Loc.—Nasratabad (Nasirabad), Seistan, No. 14; alt. 1,600′.

Local name.—Pada پدا in Steingasse's Persian Dictionary. Eng. Poplar.

Distrib.—Punjab, Sindh, Western Tibet, Western and Central Asia, and westward to Syria and Egypt.

After *Salix acmophylla*, perhaps the commonest cultivated tree in the country.

X. CHENOPODIACEAE.

16. **Halostachys**, C. A. Mey.

20. **H. caspica**, C. A. Mey. Boiss. Fl. Or. iv, 935.

Loc.—Lab-i-Baring, No. 24; alt. 1,600′.

Local name.—Pich پیچ.

Distrib.—South-east European Russia, and Western Middle Asia.

A large bush. Eaten by camels, sheep, etc.

17. **Halocnemum**, Bieb.

21. **H. strobilaceum** (Pall.), M. Bieb. Boiss. Fl. Or. iv, 936; Musch. Fl. Egypt, i, 285.

Loc.—Lab-i-Baring, No. 61; alt. 1,600′.

Distrib.—Southern Russia in Europe, Central and Western Asia, and North Africa.

Forms scrubby patches.

18. **Suaeda**, Forsk.

22. **Suaeda**, sp.

It has the habit of *S. vermiculata*, having short, loose and leafy spikes, not terminal panicles.

Loc.—Lutak, No. 79.

Local name.—کرمک - شور.

Eaten by camels.

23. **S. fruticosa**, Forsk. Fl. Br. Ind. v, 13; Boiss. Fl. Or. iv, 939; Musch. Fl. Egypt, i, 289.

Loc.—Hurmuk, No. 1; near Lutak in Seistan, No. 84; alt. 1,700′.

Distrib.—From Spain eastwards, N. Africa, West Asia, India. This is one of the several Mediterranean plants which are found in Great Britain.

In the hard bank of a small watercourse. This plant is also found in the stony desert.

24. **S. monoica,** Forsk. Fl. Br. Ind. v, 13; Boiss. Fl. Or. iv, 940; Musch. Fl. Egypt, i, 288.

Loc.—Kila-i-Rustum, Seistan, Nos. 88 and 89; alt. 1,700′.

Distrib.—India, Arabia, and Tropical Africa.

Small bushes among ruins.

19. Salsola, Linn.

25. **S. inermis** ? Forsk. Boiss. Fl. Or. iv, 955; Musch. Fl. Egpyt, i, 295.

Loc.—Lab-i-Baring, No. 41; alt. 1,600′.

Distrib.—Syria, Arabia, and Egypt.

Grows flat in stony desert.

26. **S.**, sp.

It has minute, ovate, thick leaves and the tortuous habit of *S. tetragona*.

Loc.—Lab-i-Baring, No. 74; alt. 1,600′.

In stony dry river-bed.

27. **S.** probably **subaphylla,** C. A. Mey. Boiss. Fl. Or. iv, 959.

Loc.—Lab-i-Baring, No. 69; alt. 1,600′.

Distrib.—Afghanistan, Turkistan, and the Caspian region.

Forms small bushes in dry river beds in stony desert.

28. **S. foetida,** Del. Fl. Br. Ind. v, 18; Boiss. Fl. Or. iv, 961; Musch. Fl. Egypt, i, 298.

Loc.—Hurmuk, No. 12, and Lab-i-Baring, No. 20; alt. 1,600′.

Distrib.—Upper India, Baluchistan, Persia, Arabia, and North Africa.

In sandy deserts. A hoary plant, grows flat in dry gravel. Fruiting perianth wings the colour of weak Indian ink veined with black, entirely black or scarlet.

29. **S.**, sp.

Loc.—Lab-i-Baring, Nos. 21, 22 and 75; alt. 1,600′.

Emerald green with white tomentum. Fruiting perianth segments terra-cotta to crimson, paler at base.

Grows in compact clumps about a foot high in clay, consolidated by saline deposits at the edge of small streams.

No. 22 differs from No. 21 in having paler green leaves and yellow fruiting perianth segments.

No. 75 has winged fruits varying from scarlet to black.

30. **S.**, sp.

A curious plant with densely hairy leaves.

Loc.—Lab-i-Baring, No. 38; alt. 1,600′.

A densely hairy plant. It forms small clumps in the stony desert. Fruiting perianth wings at first white, then fading to straw colour.

20. **Haloxylon,** Bunge.

31. **H. salicornicum,** Bunge. Fl. Br. Ind. v, 16; Boiss. Fl. Or. iv, 949

Loc.—Between Lutak and Girdi, No. 85.

Distrib.—Sindh, Afghanistan, Baluchistan, and Persia.

Grows as a large bush or small tree in gravelly soil.

21. **Anabasis,** Linn.

32. **A. setifera,** Moq. Fl. Br. Ind. v, 19; Boiss. Fl. Or. iv, 970; Musch. Fl. Egypt, i, 301.

Loc.—Lab-i-Baring, Nos. 23 and 59; alt. 1,600′.

Distrib.—Middle Persia, Syria, Palestine to Egypt. In India found in the Punjab.

Glaucous green. Grows on stony ground, forming small bushes with very hard woody stalk.

Fodder for camels.

33. **A. setifera,** Moq., *l.c.*

These plants have a white stem and the deciduous bristles at the tips of leaves have probably fallen off.

Loc.—Lab-i-Baring, No. 47; alt. 1,600′.

Local name.—Wăsh lund واشلُند.

Distrib.—Middle Persia, Syria, Palestine to Egypt.

This plant sometimes forms large clumps about 3 feet in diameter and a foot high. Its yellowish colour makes it a conspicuous object from afar. When it grows in stony desert it looks dull green.

It is used for cleaning white cloth. The plant is first dried, then powdered and made into a paste with water and boiled with the cloth. It has a strong foetid smell.

34. **A.,** sp.

Loc.—Harmuk, No. 8; alt. 2,000′.

In stony desert. Fruiting perianth wings dull red.

22. **Cornulaca,** Del.

35. **C. monacantha,** Del. Boiss. Fl. Or. iv, 984; Musch. Fl. Egypt, i, 302.

Loc.—Lab-i-Baring, Nos. 54 and 55, alt. 1,600′; also Makki. Afghan-Baluch Frontier. No. 92; alt. 2,500′.

Distrib.—Afghanistan, Middle Persia, and Egypt.

In the stony desert. The plant forms small clumps of extremely strong woody stems each surmounted by a crown of short branches.

23. **Halogeton,** C. A. Mey.

36. **H.** probably **glomeratus,** C. A. Mey. Fl. Br. Ind. v, 20; Boiss. Fl. Or. iv, 985.

Loc.—Lab i-Baring, No. 68; alt. 1,600′.

Distrib.—Western Tibet, Afghanistan, Turkestan, and Siberia.

Growing flat in stony desert. Looks like coral, dead white.

In addition to the species noted above a very beautiful schrobaceous shrub (No. 86) was collected at the edge of the Shelagh river (salt) in the south of Seistan. It was remarkable for its regular growth, strong aromatic odour and for the enormous number of flower-like winged fruits of a pale straw-colour tinged with pink that covered the whole plant. We have been unable to trace the genus.

XI. CARYOPHYLLACEAE.

24. **Cometes,** Linn.

37. **C. surattensis,** Linn. Fl. Br. Ind. iv, 712; Boiss. Fl. Or. i, 753.

C. abyssinica, R. Br. Musch. Fl. Egypt. i, 357.

Loc.—Hurmuk, No. 10; alt. 2,000′.

Distrib.—Sind, Baluchistan, Waziristan westward to South Arabia, Egypt, and South Africa.

In sandy deserts, forming small clumps not more than a foot high.

XII. CRUCIFERAE.

25. **Lepidium,** Linn.

38. **L. Draba,** Linn. Fl. Br. Ind. 1, 160; Boiss. Fl. Or. 1, 356; Musch. Fl. Egypt, 1, 425.

Loc.—Kila-i-Rustum, Seistan, No. 93; alt. 1,700′.

Distrib.—From the Punjab westwards to Europe.

In clay desert.

26. **Physorhynchus,** Hook.

39. **P. brahuicus,** Hook. Fl. Br. Ind. i, 165; Boiss. Fl. Or. i, 403.

Loc.—Lab-i-Baring, No. 71; alt. 1,600′.

Distrib.—From the Salt Range in the Punjab, westwards to Southern Persia.

Forms small bush in stony desert.

27. **Farsetia**, Turr.

40. **F. Jacquemontii**, Hook f. and T. Fl. Br. Ind. i, 140; Boiss. Fl. Or. i, 158.

Loc.—Hurmuk, No. 4, alt. 2,000′; and Lab-i-Baring, No. 58; alt. 1,600′.

Distrib.—From Sindh and Punjab to Afghanistan and Baluchistan.

Grows in the stony desert, where it forms small clumps. Mostly dead. Wood yellow. Root very thick and strong. Flowers straw coloured with darker veins.

28. **Moricandia**, DC.

41. **M. sinaica**, Boiss. Boiss. Fl. Or. i, 386; Musch. Fl. Egypt, i, 415.

Loc.—Lab-i-Baring, No. 49; alt. 1,600′.

Distrib.—Baluchistan, Eastern and Southern Persia, Sinai and Egypt.

In stony desert.

XIII. CAPPARIDACEAE.

29. **Cleome**, Linn.

42. **C.**, sp., near C. arabica, L., which has somewhat thicker and shorter pods.

Loc.—Hurmuk, No. 5; alt. 2,000′.

A conspicuous plant of upright growth and less bushy than most of its neighbours, very common in the stony desert at Hurmuk. It is not gregarious. Not seen at Lab-i-Baring.

30. **Capparis**, Linn.

43. **C. spinosa**, Linn. Fl. Br. Ind. i, 173; Boiss. Fl. Or. i, 420; Musch. Fl. Egypt, i, 391.

Loc.—Kila-i-Rustum, No. 90; alt. 1,700′.

Distrib.—India westward to the Mediterranean region and Egypt.

Forms small bushes among ruins.

XIV. LEGUMINOSAE.

Sub-Order *Mimoscidae*.

31. **Prosopis**, Linn.

44. **P. spicigera**, Linn. Fl. Br. Ind. ii, 288; Boiss. Fl. Or. ii, 634.

Loc.—Lab-i-Baring, No. 73; alt. 1,600′.

Distrib.—From Punjab to Western Peninsula in India, Afghanistan, Baluchistan, and Persia.

Forms small clumps not more than six inches high in stony places.

45. **P. Stephaniana,** Kunth. Fl. Br. Ind. ii, 288; Boiss. Fl. Or. ii, 633; Musch. Fl. Egypt, i, 456.

Loc.—Kila-i-Rustum, No. 91; alt. 1,700′.

Distrib.—Punjab, Afghanistan, Western Asia to Turkestan.

Forms small bushes among ruins.

Sub-Order *Papilionaceae.*

32. **Astragalus,** Linn.

46. **A. gerensis,** Boiss. Boiss. Fl. Or. ii, 300.

Loc.—Lab-i-Baring, No. 39: alt. 1,600′.

Distrib.—Persia, Baluchistan.

Grows in the stony desert. Mr. Hughes-Buller observed that animals graze on it, and people eat the seeds of the fruit. (Burkill's Flowering Plants of Baluchistan, 24).

47. **A.,** sp. or **Traverniera.**

Loc.—Lab-i-Baring, No. 67; alt. 1,600′.

Forms compact clumps in stony desert. Mostly dead with a few green shoots.

33. **Alhagi,** Tournf.

48. **A. camelorum,** Fisch. Boiss. Fl. Or. ii, 559.

Loc.—Lutak, Seistan, No. 77.

Local name.—Khar خار. Eng. Camelthorn.

Distrib.—Afghanistan, Baluchistan and from Persia to the Caspian region.

The dominant plant in the immediate neighbourhood of irrigated land. Eaten by camels, etc.

XV. ZYGOPHYLLACEAE.

34. **Fagonia,** Tournf.

49. **F. Bruguieri,** DC. Fl. Br. Ind. i, 425; Boiss. Fl. Or. i, 905; Musch. Fl. Egypt, i, 581.

Loc.—Lab-i-Baring, No. 48; alt. 1,600′.

Local name.—Khari kui خارِ کُوئی.

Distrib.—North-west India, westward to Algeria.

Grows flat in stony desert. It is eaten by goats and camels. It is often infested with galls.

35. **Zygophyllum,** Linn.

50. **Z. atriplicoides,** Fisch et Mey. Boiss. Fl. Or. i, 911

Loc.—Lab-i-Baring, No. 72; alt. 1,600′.

Distrib.—Baluchistan, North Persia and Armenia.

Forms small straggling bushes in stony river bed.

36. **Tribulus**, Tournf.

51. **T. alatus**, Del. Fl. Br. Ind. i, 423; Boiss. Fl. Or. i, 902; Musch. Fl. Egypt. i, 573.

Loc.—Hurmuk, Seistan, Nos. 7 and 11, alt. 2,000′; Lab-i-Baring, Nos. 42 and 45, alt. 1,600′.

Distrib.—Sind and Punjab in India, Arabia, Syria, Egypt.

In stony desert, flowers sometimes white and sometimes yellow.

37. **Peganum**, Linn.

52. **P. Harmala**, Linn. Fl. Br. Ind. i, 486; Boiss. Fl. Or. i, 917; Musch. Fl. Egypt, i, 571.

Loc.—Lab-i-Baring, No. 53, alt. 1,600′; Lutak, No. 78, and Kila-i-Rustum, No. 87; alt. 1,700′.

Local name.—Sipand سپند.

Distrib.—From Delhi and Agra to Kashmir and the Western Deccan, Soongaria, Arabia, N. Africa westward to Hungary and Spain.

Forms irregular groves in stony jungles with Aphides. Forms dunes. Eaten by goats and sheep.

XVI. RUTACEAE.

38. **Ruta**, Linn.

53. **R.** sp.

Loc.—Lab-i-Baring, No. 57; alt. 1,600′.

Local name—Gamart گامرت.

Woody dead stocks, about a foot high, bear a few living shoots. The flowers are pale greenish yellow. This plant is said to be very poisonous to animals.

XVII. EUPHORBIACEAE.

39. **Andrachne**, Linn.

54. **A. telephioides**, Linn. Fl. Br. Ind. v, 284; Boiss. Fl. Or. iv, 1138; Musch. Fl. Egypt, i, 596.

Loc.—Lab-i-Baring, No. 37; alt. 1600′.

Distrib.—Punjab, Afghanistan, westward to Spain and Cape Verd Islands.

Grows flat in stony desert and has flowers on the lower surface of the flattened branches.

40. **Euphorbia**, Linn.

55. **E. granulata**, Forsk. Fl. Br. Ind. v. 252; Boiss. Fl. Or. iv, 1089; Musch. Fl. Egypt, i, 600.

Loc.—Hurmuk, No. 3, alt. 2,000′; Lab-i-Barīng, Nos. 35 and 36, alt. 1,600′.

Local name.—Mashera مشیره.

Distrib.—Sind, Punjab, Afghanistan to Syria, Egypt and Canaries.

Grows flat in stony desert. There are two colour forms, one with both foliage and flowers green and the other has foliage varying from pink to glaucous green and crimson involucres with white glands. The two forms often grow together, sometimes actually interdigitating.

XVIII. TAMARICACEAE.

41. **Tamarix,** Linn.

56. **T. stricta,** Boiss. Fl. Br. Ind. i, 249; Boiss. Fl. Or. i, 778.

Loc.—Lab-i-Baring, No. 19; alt. 1,600′.

Local name.—Gaz گز.

Distrib.—Baluchistan.

A shrub. Grows everywhere near or fairly near water however saline but it avoids stony ground. Provides most of the fire-wood of the country.

57. **T.,** sp.

Loc.—Nasratabad, No. 76; alt. 1,700′.

Local name.—Kura Gaz کُره گز.

This name is sometimes given to *T. articulata*, which this plant is not.

A tree Tamarix found only in gardens but said to be common near the Helmund River. From it punting poles, looms, etc. are made.

XIX. UMBELLIFERAE.

42. **Ducrosia,** Boiss.

58. **D. anethifolia,** (DC.) Boiss., probably. Boiss. Fl. Or. ii, 1,036.

Loc.—Lab-i-Baring, No. 50; alt. 1,600′.

Distrib.—Baluchistan, Persia and Assyria.

Forms small scattered rosettes in stony desert.

XX. SCROPHULARIACEAE.

43. **Schweinfurthia,** A. Braun.

59. **S. sphaerocarpa,** A. Braun. Fl. Br. Ind. iv, 252 Boiss. Fl. Or. iv, 387.

Loc.—Lab-i-Baring, No. 51; alt. 1,600′.

Distrib.—Sind, Afghanistan and Baluchistan.
Forms large, flat rosettes in stony jungles.

44. **Scrophularia**, L.

60. **S.**, sp., near **marginata.**
Loc.—Lab-i-Baring, No. 52 ; alt. 1,600′.
Forms loose clumps in stony desert.

XXI. CONVOLVULACEAE.

45. **Cressa**, Linn.

61. **C. cretica**, Linn. Fl. Br. Ind. iv, 225 ; Boiss. Fl. Or. 114 ; Musch. Fl. Egypt, ii, 760.

Loc.—Lab-i-Baring, No. 44, alt. 1,600′ ; and Lutak, No. 82.

Local name.—Lujak لوجک.

Distrib.—All warm regions.

Grows only on very friable dry soil mixed with fine gravel. Branches always prostrate.

XXII. BORRAGINACEAE.

46. **Heliotropium**, Linn.

62. **H. luteum**, Poir. Fl. Br. Ind. iv, 148 ; Boiss. Fl. Or. iv, 141 ; Musch. Fl. Egypt, ii, 786.

Loc.—Hurmuk, Seistan, No. 13 ; alt. 2,000′.

Distrib.—Arabia, Syria, Palestine, Egypt and North Africa.

In sandy desert.

63. **H. arbainense**, Fresen. Boiss. Fl. Or. iv, 146 ; Musch. Fl. Egypt, ii, 786.

Loc.—Lab-i-Baring, No. 33 ; alt. 1,600′.

Local name.—Gul-i-kū,ī. گُل کوئی

Distrib.—Afghanistan, Arabia and Tropical Africa.

Grows flat in the stony desert. Corolla white with yellow centre.

64. **H. undulatum**, Vahl. Fl. Br. Ind. iv, 150 ; Boiss. Fl. Or. iv, 147 : Musch. Fl. Egypt, ii, 787.

Loc.—Lab-i-Baring, No. 65 ; alt. 1,600′.

Distrib.—Upper India, West Asia and North Africa.

XXIII. CUCURBITACEAE.

47. **Citrullus**, Linn.

65. **C. Colocynthis** (L.), Schrad. Fl. Br. Ind. ii, 620 ; Boiss. Fl. Or. ii, 759 ; Musch. Fl. Egypt, ii, 938.

Loc.—Lab-i-Baring, No. 43 ; alt. 1,600′.

Local name.—Pair پائیر.

Distrib.—India, West Asia, Arabia, Africa (excepting the Cape), and Spain.

Grows in the stony desert. The Seistanis scoop out the fruit and fill it with milk, which they leave standing in it over night. The milk is then used as a medicine for stomach-ache. The dried pulp of the fruit freed from the seeds is the Colocynthidis pulpa of the British Pharmacopoeia.

XXIV. COMPOSITAE.

48. **Pulicaria,** Gaertn.

66. **P. gnaphalodes,** Boiss, probably. Fl. Br. Ind. iii, 299 ; Boiss. Fl. Or. iii, 203.

Strabonia gnaphalodes, DC. Prod. v, 481.

Loc.—Lab-i-Baring, No. 70 ; alt. 1600′.

Distrib.—Western Tibet, Afghanistan and Persia.

49. **Artemisia,** Linn.

67. **A. scoparia**, Waldst et Kit. Fl. Br. Ind. iii, 323 ; Boiss. Fl. Or. iii, 364.

Loc.—Lutak, No. 81.

Local name.—Daruna درونه.

Distrib.—Upper India, Western Tibet, Afghanistan to central Europe, and Japan.

Eaten by cattle, goats, etc.

68. **A.**, sp. near **A. herba-alba,** Asso. Boiss. Fl. Or. iii, 365 ; Musch. Fl. Egypt, ii, 1012.

Loc.—Lab-i-Baring, No. 34 ; alt. 1,600′.

Distrib.—Western Asia, North Africa and Spain.

Grows in stony desert and has a strong smell. The Seistanis dry and powder it by hand and at night put the powder into water, which they drink the first thing in the morning. This draught is said to be good for the heart.

69. **A.**, sp.

Loc.—Makki, Afghan-Baluch Frontier, No. 94 ; alt. 2,500′.

Very abundant in stony desert, perhaps the most abundant in the western part of the Nushki desert. Smell very strong.

50. **Launaea,** Cass.

70. **L. spinosa,** Sch. Bip. in Webb and Berth Canar ii, 428 ; Musch. Fl. Egypt, ii, 1061.

Zollikoferia spinosa, Boiss. Fl. Or. iii, 826.

Loc.—Lab-i-Baring, No. 40 ; alt. 1,600′.

Local name.—Zīr-i-kū,ī زیرِ کُوئی.

Distrib.—Arabia, Palestine, Egypt and the Mediterranean region.

Forms clumps about a foot high in the stony desert.

VII. SYSTEMATIC LIST OF FODDER-PLANTS COLLECTED IN SEISTAN BY MAJOR F. W. THOMAS.

POLYGONACEAE.

Calligonum, Linn.

1. **C. polygonoides**, Linn. Fl. Br. Ind. v, 22; Boiss. Fl. Or. iv, 1000.

Major Thomas, Nos. vii and xxvii.

Local name.—Phog ; Narainjar.

Distrib.—From Sindh to Punjab, Persia, Armenia and Syria.

A good fodder when green.

Pteropyrum, Jaub and Spach.

2. **P. Oliverii**, Jaub and Spach. Fl. Br. Ind. v, 23; Boiss. Fl. Or. iv, 1002.

No. iv.

Local name.—Karwan Kuch.

Distrib.—Sindh, Afghanistan and Persia.

Reckoned as a fair fodder. It is called by the Beluch name Karwan Kuch or the Killer of Caravans because it is said that a caravan once tried in the winter at Wad to light a fire of this wood and failing perished of cold.

CHENOPODIACEAE.

Atriplex, Tournef.

3. **A. crassifolia**, C. A. Mey. Fl. Br. Ind. v, 6; Boiss. Fl. Or. iv, 909.

No. xxii.

Local name.—Loree chak.

Distrib.—North-Western India, Afghanistan, Turkestan, Soongaria to the Altai Mountains.

A good fodder.

4. **S.**, probably **S. fruticosa**, Forsk. *loc. cit.*

Local name —Lani.

Used as fodder.

5. **S. foetida**, Del. *loc. cit.*

No. xvi.

Local name.—Lana ; Shakranchar in Beluch.

A very good fodder.

6. **H.**, sp.

Nos. v, vi and xxiv.

Local name.—Lani, Khar Lani, Gundrem.

As fodder reckoned by some as good while others take it as fair.

7. **C.**, sp.

No. xv.

Local name.—Taran.

A very good fodder.

8. **C. spinosa**, L. var. **leucophylla**, DC. Fl. Br. Ind. i, 173.

No. xviii.

Local name.—Kumtico or Kawarg in Beluch ; Chhapa, Beri.

Distrib.—India and Persia.

A good fodder.

RESEDACEAE.

Ochradenus, Del.

9. **O. baccatus**, Del. Fl. Br. Ind. i, 182 ; Boiss. Fl. Or. i, 422 ; Musch. Fl. Egypt, i, 443.

Nos. viii and xxiii.

Local name.—Buzhom, Gulsheboo, Kanbrui.

Distrib.—Sindh westward to Syria and Egypt.

A good fodder but scarce. Others accept it as good for the country but only fair in comparison with others.

10. **P. stephaniana**, Kunth. *loc. cit.*

Local name.—Jandi.

A good fodder.

11. **A. maurorum**, Desv. Fl. Br. Ind. ii, 145 ; Boiss. Fl. Or. ii, 558 ; Musch. Fl. Egypt, i, 536.

Local name—Jawan.

Distrib.—India, Arabia and North Africa.

Well known as a camel fodder.

12. **Z. atripicoides**, F. and M. *loc. cit.*

No. xxviii.

Local name.—Kharech.

A very good fodder.

CELASTRACEAE.

Gymnosporia, W. and A.

13. **G. montana.** Fl. Br. Ind. i, 621.

Celastrus senegalensis, Lam. Boiss. Fl. Or. ii, 11.

No. xix.

Local name.—Kalor, Kangrer.

Distrib.—Most parts of India, Afghanistan, Central Africa, Malay Peninsula and Australia.

As a fodder reckoned only as fair.

TAMARICACEAE.

Tamarix, L.

14. **T. articulata**, Vahl. Fl. Br. Ind. i, 249; Boiss. Fl. Or. i, 777; Musch. Fl. Egypt, i, 649.

No. xxi.

Local name.—Guz. Okan.

Distrib.—India, Baluchistan and westward to Egypt and Africa.

A good fodder in winter season.

15. **T.**, sp.

No. ii.

Local name.—Guz or Lai.

A good fodder.

16. **T.**, sp.

Showing fasciation of branches.

No. xxxi.

Local name.—Lei.

Held to be poisonous to cattle.

Gymnocarpos, Forsk.

16. **G. fruticosum**, Pers. Fl. Br. Ind. iv, 712; Boiss. Fl. Or. i, 748.

G. decandrum, Forsk. Fl. Æg. Arab. tab. x, 65.

G. decander, Forsk. Musch. Fl. Egypt, i, 354.

No. xvii.

Local name.—Harmazong, Khartus.

Distrib.—Baluchistan, from Persia westward to the Mediterranean region.

A good fodder.

Pycnocycla, Lindl.

17. **P. Aucheriana**, Dcne. Boiss. Fl. Or. ii, 952.

No. xx.

Local name.—Ispaipal Kandiora.

Distrib.—Baluchistan, Persia and Arabia.

Considered fair as a fodder.

SOLANACEAE.

Lycium, L.

18. **L. barbarum**, L. Fl. Br. Ind. iv, 241; Boiss. Fl. Or. iv, 289

L. barbarum, L. var. *vulgare*, Ait. Hort. Kew, p. 3.

L. vulgare, Dun. DC. Prodr. xiii, 509, Musch. Fl. Egypt, i, 850.

Local name.—Kungu or Kandiana.

Distrib.—Sind and Punjab, probably a native of Western Asia now found in Europe and the East.

LABIATAE.

Perowskia, Kar.

19. **P. abrotanoides,** Karel. Boiss. Fl. Or. iv, 589.
No. 9.
Local name.—Maur.
Distrib.—Persia and Khorasan.
A good fodder.

20. **Artemisia,** sp., near Herba alba.
Nos. iii and xxvi.
Local name.—Dharanak, Dharanakai.
A good fodder.

* * *

DESCRIPTION OF PLATES.

Photographs of herbarium specimens of two grasses from Seistan, illustrating the direct effect of abnormal environment on the plant. All the figures are on the same scale, viz., one half natural size.

PLATE V.

Normal specimen of *Phragmites ? communis* (intermediate between *P. communis* and *P. Karka*) from the edge of the Hamun-i-Helmand at Lab-i-Baring. Note the large size of the inflorescence, the comparatively lax, broad leaves and the thickness of the stem. This plant was between 12 and 15 feet high and grew at the edge of nearly fresh water.

PLATE VI.

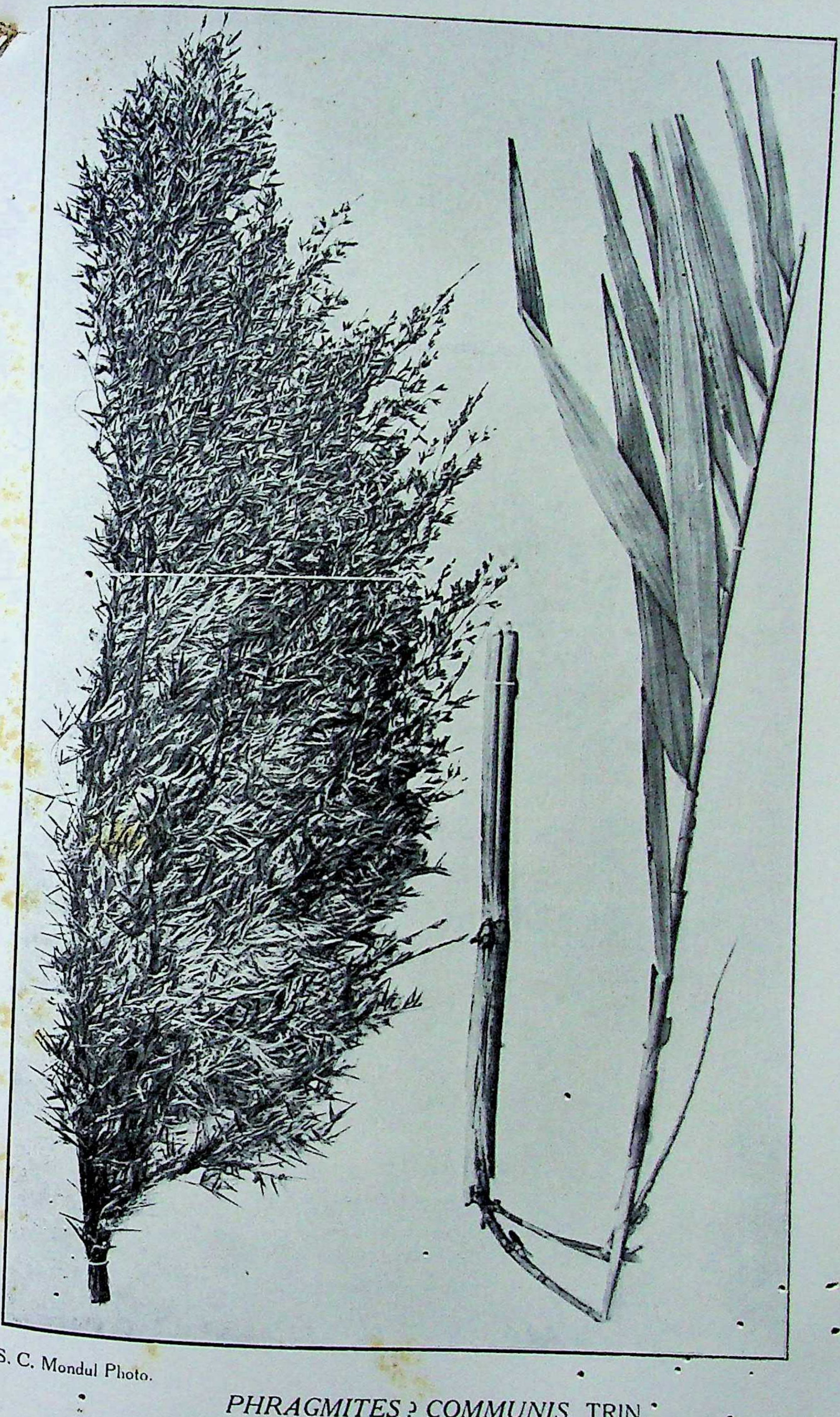
Specimens of the same reed from the edge of a stream of strongly saline water running down towards the Hamun (and doubtless reaching it after rain) in the same neighbourhood. Note the dwarfing of the whole plant, and especially of the inflorescence, and the stiff, upright, sharply pointed leaves.

PLATE VII.

Dwarfed specimens of *Aeluropus villosus* from the stony desert at Lab-i-Baring, in which they form low, dense clumps, often with fairly long radiating sessile shoots. The leaves are small and soft.

PLATE VIII.

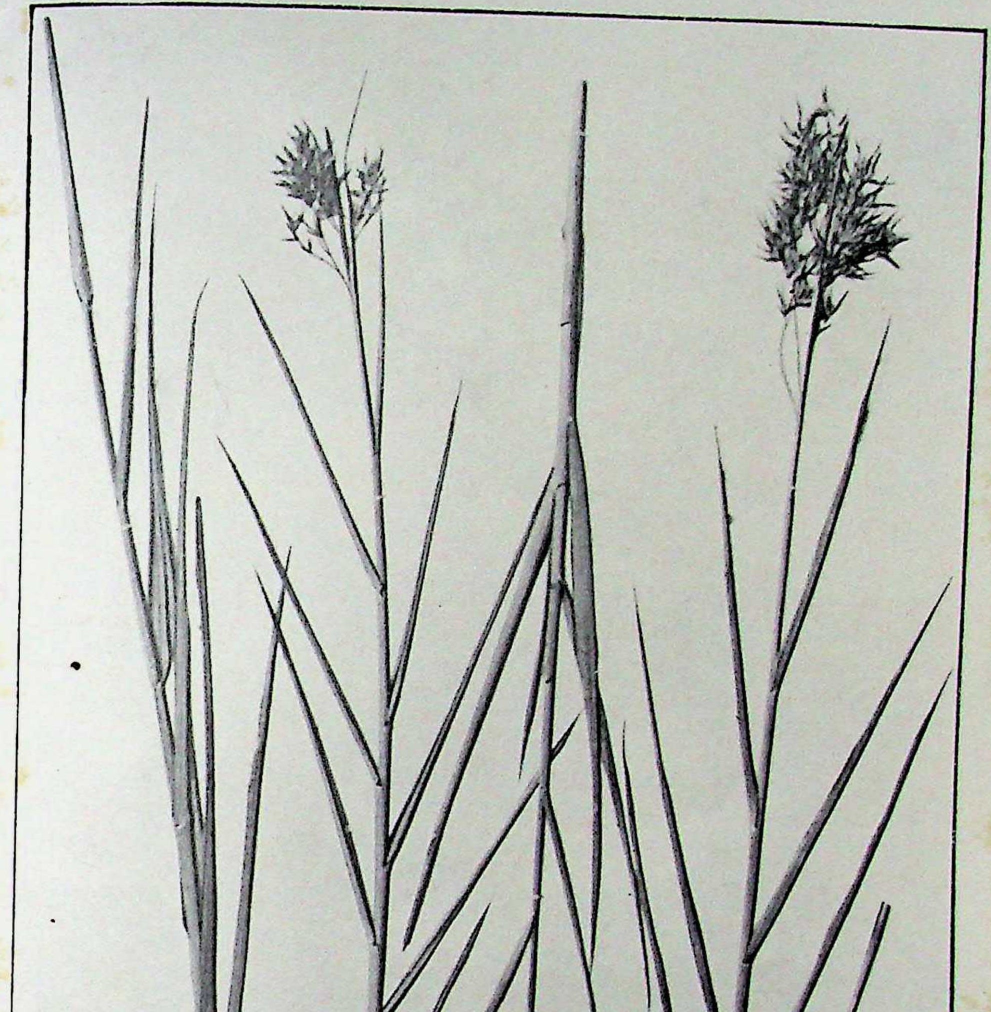
Larger specimens of the same grass from the edge of a stream of saline water in the same vicinity. Note, again, the stiff, upright, sharply-pointed leaves, but also the *enlarged* size and upright growth of the plant. These specimens were from the edge of a stream the water of which contained 20·265 grammes of alkalies (weighed as chlorides) in 1,000 c.c.



S. C. Mondul Photo.

PHRAGMITES ? COMMUNIS, TRIN.

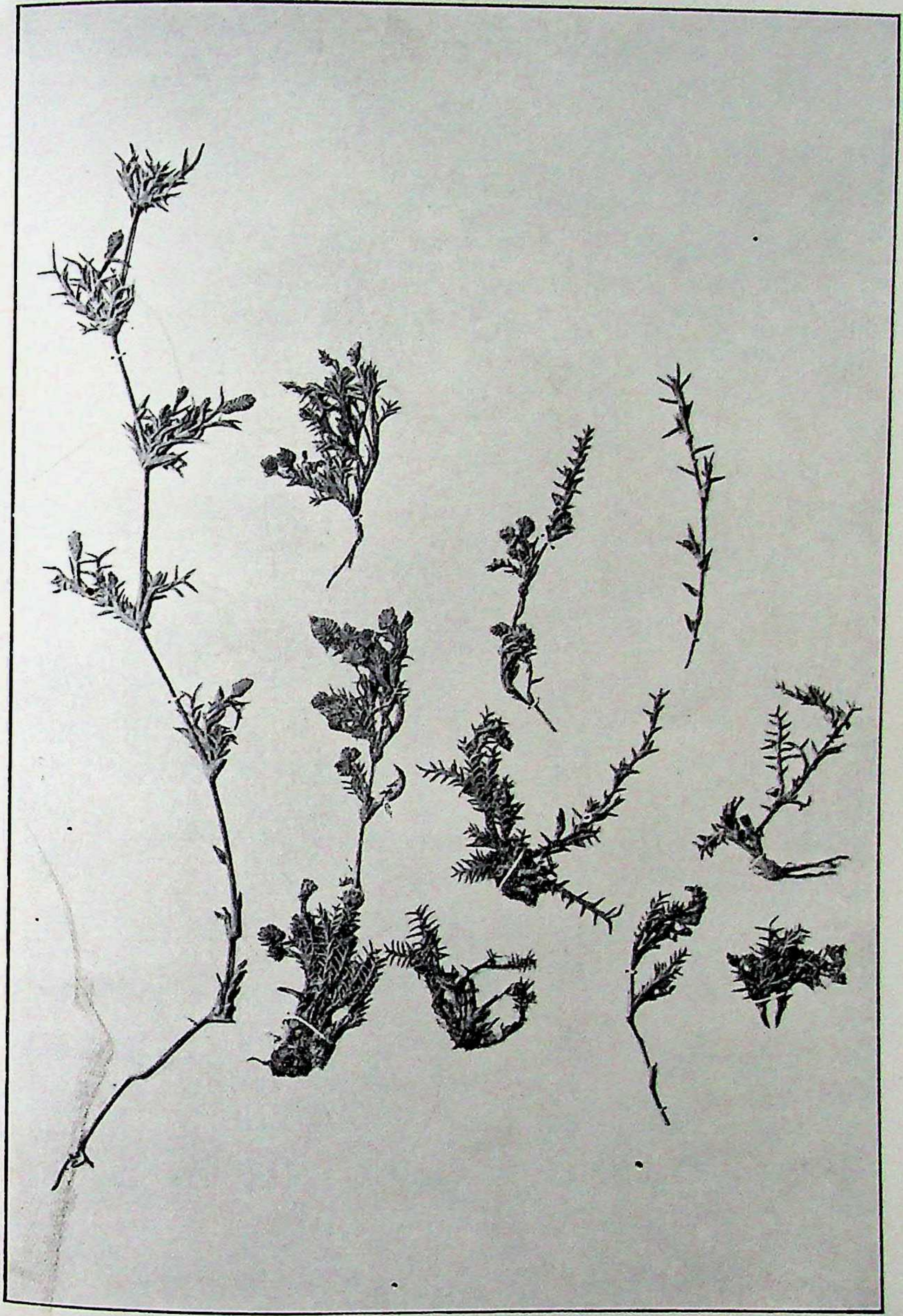
(Normal lacustrine form), × ½.



S. C. Mondul Photo.

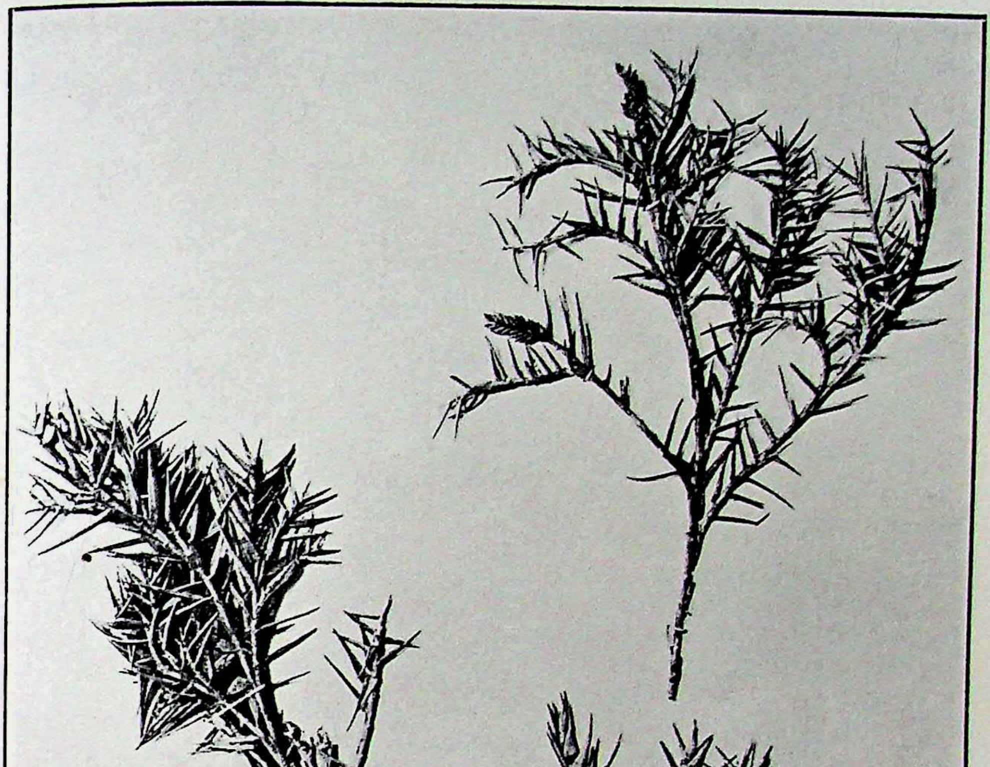
PHRAGMITES? COMMUNIS, TRIN.

(Depauperated halophytic form), x $\frac{1}{2}$.



S. C. Mondul Photo.

AELUROPUS VILLOSUS, TRIN.
(Prostrate desert form), x ½.



S. C. Mondul Photo.

AELUROPUS VILLOSUS, TRIN.
(Erect halopytic form), x $\frac{1}{2}$.

16. Radiation Pressure.

The fallacy in Larmor's proof.

By Elder Barter, B.A., I.C.S.

The generally accepted method of arriving at the magnitude of the pressure due to radiation incident normally on a perfect reflector is that given by Sir Joseph Larmor (Encyc. Brit., 10th Edition). This treatment is applied to a wave train of *any* kind, and requires an imaginary screen placed in the medium, able to move through the medium itself, while acting as a perfect reflector, and so confining all disturbances to one side of it. If such a screen advances against the incident radiation, the reflected waves are of the same amplitude, but of shorter wave-length than the incident waves, and have more energy. It is shewn that in this case,—" the energy transmitted per unit time is increased by reflection, and this increase per unit time can arise only from work done by the advancing reflector against pressure exerted by radiation." It is thus deduced that this pressure is equal to the average energy density in the medium in front of the reflector.

Lord Rayleigh however has shown (Phil. Mag. X, 1905. p. 364) that sound waves in gases may exert positive, zero or negative pressure, according to the relation between the pressure and density of the gas. The case where no pressure is exerted is that in which the wave is propagated without change of form. This is exactly the case considered by Sir Joseph Larmor.

It seems necessary therefore to enquire into the validity of the assumption that the work done by the advancing reflector is done against a pressure due to the radiation, i.e. is a measure of the average pressure exerted by the radiation on a stationary reflector.

The condition that the waves shall be completely reflected is that the medium behind the advancing reflector shall always be undisturbed. The reflector considered in Sir Joseph Larmor's treatment does not move the medium as a whole with it, but moves through the medium, leaving that behind it, unaffected by the strain in front of it. If it moved through an undisturbed medium, it would exert no force on the medium. If the medium in front is strained it must still be passed through to the back of the reflector at such a rate that it emerges unstrained, i.e. at the same rate as if the whole medium was undisturbed. In advancing thus the reflector does work on and increases the strain energy in the medium, by an amount which can be found as follows.

Consider the medium with the reflecting surface at S (fig. 1). Let the medium B to the left, be undisturbed, or in the case of a gas, at the normal pressure ; and let the medium A to the right be in vibration. During an interval of time, short compared with the period, we may suppose the strain in the medium A to remain constant, while the surface S moves to S', a distance short compared with the length of the incident waves.

As an example we will treat with the case of sound waves in a gas The pressure at any instant on a stationary reflector at S is the difference between the pressure in A, and the normal pressure in B.

Now let the reflector move to S'. The gas in B has remained undisturbed, and that now in SS' is also at the normal pressure. To find the increase in the energy of the gas, i.e. the work done by the reflecting surface, it is convenient to consider this condition as produced in a somewhat different manner.

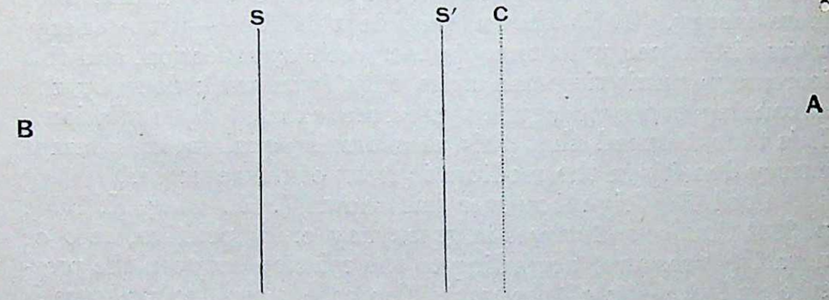


Fig. 1.

Let SC represent the length occupied by the gas, which when brought to the normal pressure occupies SS'. Then let the reflector remain at S, while another screen, impervious to the gas, is inserted at C, and is then moved to S'. The gas in SS' is now at the normal pressure, and the reflector can be removed, and substituted for the screen at S'. We have now the same conditions as those given by the advance of the reflector from S to S', and the work done on the gas will be the same in each case.

We can investigate the work done with the aid of a diagram (fig. 2).

The figure represents the conditions when A is rarefied. The heights of the horizontal lines above XY represent the pressures. The normal pressure is LN, the pressure in A is MN. The instantaneous pressure on the reflector, due to the wave, is LM and is negative.

After the movement of the reflector to S', the pressures are DH and EH of the same magnitude as before, because SS' is short. Let DF be the pressure-volume line for gas now in SS', F being on the line ME. Then F gives us the first position, C, of the impervious screen. This screen, in compressing the gas SC to SS', does work represented by the area $DFGH$. The gas in A does work on it, represented by $EFGH$. Thus the work done by the reflector in the displacement SS' is positive, and is represented by the area DFE. The work which would be equal to the product of the pressure on the reflector, and its displacement, is represented by the area $LDEM$ and is in this case negative.

The work done by the reflector when the gas in A is compressed, can be found similarly.

It is thus shown that the instantaneous rate of working, is not given by the instantaneous pressure on the reflector, and its velocity. Hence the average rate at which a moving reflector does work is not a direct measure of the pressure on a stationary reflector.

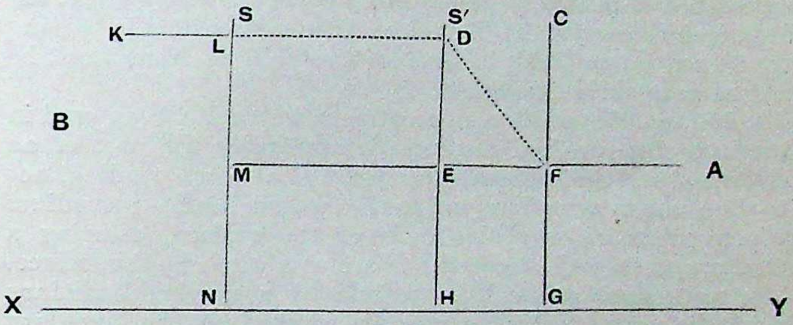


Fig. 2.

This reasoning can be applied to strains in any material media. The following illustration may make it clearer. An elastic cord is stretched, and the ends fixed. A man pulls along it with one hand, so that one part of it is now just unstretched. He is then to move along towards the stretched part, in such a way, that the part behind him is always just unstretched. He can do this, as he holds the cord in say, his right hand, by taking it in front with his left hand, and pulling his left hand towards him, till the cord between his hands is just unstretched. Then he can move his right hand to the front of his left hand, and so on. In this way, he does work on the cord, although he is moving in the direction of the force exerted on him by the cord, when he is stationery.

In the case of an electric-field, this treatment must be modified. Let there be an electric field in A, with displacement parallel to the surface at S, and no field in B. It was shown by Maxwell that such a field exerts a pressure on the surface at S, and is in this respect, similar to the compressed part of a medium.

Consider as before the case of a compressed medium. When the surface has moved from S to S' the medium between S and S' must now be unstrained, and must originally have occupied a space SC, where C is between S and S'. In this case work has been done on the medium in A, and all strain energy has been taken from the medium in SC in its expansion to SS'.

In the case of the electric field, if a part of the field occupying SC could give up all its energy in expanding to SS', we should have conditions similar to those in the case of the compressed medium, and the work done by the surface S in moving to S' would be found in the same way. But the field in SC in expanding to SS' will not lose the whole of its energy, unless SS' is infinitely great, in comparison with SC, i.e. unless C coincides with S. Therefore if the surface at S in moving to S', leaves no field behind it, the field in front must be moved as a whole through SS'.

If then the method of treatment which has been used in the case of a strained medium, is applied to the case of an electric field, the field must be regarded as corresponding, not to the strain in a medium, but to the medium itself,—a medium which exists on one side only of the surface, exerting a pressure on it, and is moved forward as a whole by the surface. The work done on such a medium by a moving boundary would be measured by the pressure exerted on the boundary and the distance it has moved. If the field varies in intensity, the average rate at which work is done by a uniformly moving reflector, is a measure of the average pressure on it.

It would appear therefore, that the assumption that the work done by the advancing reflector is done against a pressure exerted by the radiation reflected, is not valid in the case of strain waves in material media; and that in the case of electrical disturbances, it can only be justified by further consideration of the properties of the electric field.

Proceedings of the Ordinary General Meetings, 1919.

FEBRUARY, 1919.

The Monthly General Meeting of the Society was held on Wednesday, the 5th February, 1919, at 9-15 P.M.

The following eight gentlemen were balloted for as ordinary members:—

Srijut Sasadhar Roy, M.A., B.L., Vakil, High Court, 31, Haris Mukerjee's Street, Bhowanipur, proposed by Dr. B L. Chaudhuri, seconded by Mr. Hem Chandra Das-Gupta; *Shaik Abdul Kadir Surfraz*, M.A., Professor, Elphinstone College, Bombay, proposed by Dr. Harold H. Mann, seconded by Mr. D. B. Parasnis; *Mr. V. M. Galoostian*, Professor of Armenian Literature and History, 38, Theatre Road, Calcutta, proposed by Mr. M. J. Seth, seconded by Dr. W. A. K. Christie; *Rev. J. C. Manry*, M.A., Professor of Psychology, Ewing Christian College, Allahabad, proposed by Dr. S. K. Belvalkar, seconded by Dr. W. A. K. Christie; *Mr. Mehtab Singh Obroj*, Demonstrator in Science, Gordon College, Rawal Pindi, proposed by Mr. A. C. Woolner, seconded by Lieut.-Col. J. Stephenson, I.M.S; *Mr. Tarak Nath Mukherjee*, First Class certificated colliery manager, Faika Colliery, Nirshachate P.O. (Manbhoom), proposed by Dr. B. L. Chaudhuri, seconded by Mr. Hem Chandra Das-Gupta; *Mr. G. Yazdani*, Government Epigraphist for Muslim Inscriptions and Nazim, Archaeological Department, Hyderabad, proposed by the Hon. Dr. A. Suhrawardy, seconded by Dr. W. A. K. Christie; *Mr. Ghulam Mohi-ud-din Sufi*, B.A., Superintendent, Normal School, Amraoti, proposed by Rai Bahadur Heralal, seconded by the Hon. Dr. A. Suhrawardy.

The General Secretary reported that Lieut.-Col. J. T. Calvert, I.M.S., had expressed a desire to withdraw from the Society.

The President called attention to the following exhibitions:—

1. Ten Moslem manuscripts.—A. Suhrawardy.
2. Some specimens acquired from Central Asia and some excavated at Bhita —D. R. Bhandarkar.
3 Four manuscripts and a Buddhist dāgobā.—Satis Chandra Vidyabhusana.

4. Three statues representing Hevajra, the birth of Tara and Vajrapani.—E. Vredenburg.

5. Two portraits of His Holiness Yon-tan rgya-mts's. —E. Vredenburg.

6. An illuminated palm-leaf manuscript copy of the Astasahasrika Prajnaparimita.—Satis Chandra Vidyabhusana and E. Vredenburg.

7. An illuminated Quran. Dated 1025 A.H. (1617 A.D. approx.).—E. Vredenburg and A. H. Harley.

8. Some Indian substitutes for imported drugs.—H. G. Carter.

9. Palaeolithic implements.—H. H. Hayden.

10. Carnivorous Dinosaurian remains from the Lameta beds at Jubbulpore—vertebrae, dermal scutes, etc.—The Geological Survey of India.

11. Micro-sections of "Lavas" formed by the burning of coal seams.—L. L. Fermor.

12. A series of recent and fossil Cyprœidæ and Ovulidæ. —E. Vredenburg.

13. A specimen of Cryptozoon from the pre-cambrian rocks of Raipur.—E. Vredenburg.

14. Slides of augite-diorite from Jaunsar Bawar showing micropegmatite.—Hem Chandra Das-Gupta.

15. A representative collection of Indian butterflies.—F. H. Gravely.

16. Model and photographs of the tutin or ark of bull-rushes used by the Gaodar and Sayad tribes of the Hamun-i-Helmand.—N. Annandale and S. W. Kemp.

The President announced that there would be no meeting of the Medical Section during this month.

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MARCH, 1919.

The Monthly General Meeting of the Society was held on Wednesday, the 5th March, 1919, at 9-15 P.M.

MAHAMAHOPADHYAYA HARAPRASAD SHASTRI, C.I.E., M.A., F.A.S.B., President, in the chair.

The following members were present :—

Moulavi Abdul Wali, Mr. W. E. Andrews, Dr. N. Annandale, Mr. A. C. Atkinson, Dr. P. J. Brühl, Babu Nilmoni Chakravarthi, Mr. J. A. Chapman, Dr. B. L. Chowdhuri, Miss M. L.

Cleghorn, Mr. H. G. Graves Dr. G. E. Pilgrim, Dr. Beni Prasad, Mr. G H. Tipper, Dr. Satish Chandra Vidyabhusana, Mr. E. Vredenburg.

Visitors:—Mr. G. D. Allen, Babu Brindaban Ch. Bhattacharjee, Miss O. Cleghorn, Mr. B. Das-Gupta, Mahamahopadhyaya Pandit Rai Jadabeswar Tarkratna.

The minutes of the December Ordinary Monthly Meeting, the Annual Meeting and the February Ordinary Monthly Meeting were read and confirmed.

Thirty-six presentations were announced.

The General Secretary reported that Mr. E. Moloney, an ordinary member, had expressed a desire to withdraw from the Society.

The General Secretary also reported the death of Dr A. F. R. Hoernle, an Honorary Fellow of the Society.

Mahamahopadhyaya Haraprasad Shastri read an obituary notice of Dr. Hoernle.

Dr. A. F. R. Hoernle, Ph.D., M.A., came to India as a professor of the Jaynarayana Missionary College of Benares. There he attracted the attention of the learned world by his comprehensive and accurate grammar of the Gaurian languages by which he meant the languages of Northern India. He came to Calcutta in the early eighties as professor of the Cathedral Mission College and joined the Asiatic Society of which he soon became one of the leading spirits. On the abolition of that college Dr. Hoernle was taken into the Indian Educational Service and served for some time as professor of the Presidency College and then as principal of the Madrasa College. His father was in British service in India and during the youth of Dr. Hoernle was several times transferred from province to province. This gave an opportunity to young Hoernle to master the spoken dialects of these different provinces. He improved upon this opportunity later by studying them systematically and scientifically. In the eighties few studied epigraphy and paleography but Dr. Hoernle employed the whole energy of his mind to their study, and deciphered with wonderful accuracy the Buxali manuscript. His linguistic studies brought him into close relationship with G. A. Grierson (now Sir George) and they jointly attempted the publication of a dictionary of Behari dialects. Dr. Hoernle's great work is his Bower MSS., written on birch bark in the Indian character of the 4th and 5th centuries A.D., on medicine, on necromancy and on astrology. The work, which appeared in several parts, is a monument not only of the talents and skill of Dr. Hoernle in deciphering and explaining technical terms but also of the liberality of the Government which supported him. The medical work in the Bower MSS. is sometimes called Navanitaka, i.e. the cream of the medical science. It is from the study of this work that Dr. Hoernle acquired a taste for the medical sciences of the Hindus to which he devoted the latter years of his life. His great work, the Osteology of the Hindus, showed how the Vaidik Aryans at that remote period of antiquity knew and studied the anatomical structure of men and beasts. Dr. Hoernle was preparing a translation of the two standard works on Hindu medicine and surgery, viz. the Caraka Samhita and Susruta Samhita, and it is a great loss to the scientific world that he has been called to the other world before completing it. For nearly 20 years he was an ornament and an attraction to the Society, and his Presidential address in 1898 still rings in my ears as a supreme effort of wide reading and deep scholarship. How keen the admiration of the public was after the delivery of the address may be gauged by the offers he received from various universities to serve them in various capacities. He could not however avail himself of these offers as he was hurrying home after his retirement and collecting together the vast materials which he projected to work upon in his quiet retreat at Oxford.

The following two gentlemen were balloted for as ordinary members:—

Mr. H. W. B. Moreno, B.A., Ph.D., M.R.A.S., Professor of English Literature, Central College, 12, Wellesley Street, Calcutta, proposed by Mr. E. Vredenburg, seconded by Dr. W. A. K. Christie; *Babu Sivaprasad Gupta*, Zemindar, Sivā-Upavana, Benares City, proposed by Mahamahopadhyaya Haraprasad Shastri, seconded by Dr. W. A. K. Christie.

The General Secretary read the names of the following gentlemen who had been appointed to serve on the various committees during 1919:—

Finance Committee.

President, Treasurer, Secretary (*ex officio*), Dr. N. Annandale, Dr. Satis Chandra Vidyabhusana, The Hon. Justice Sir Asutosh Mukhopadhyaya, Kt., Dr. F. H. Gravely.

Library Committee.

President, Treasurer, Secretary, Anthropological Secretary, Biological Secretary, Physical Science Secretary, the two Philological Secretaries, Medical Secretary, Hon. Librarian (*ex officio*), J. A. Chapman, Esq., D. R. Bhandarkar, Esq., The Hon. Mr. W. C. Wordsworth.

Philological Committee.

President, Treasurer, Secretary (*ex officio*), The Hon. Dr. Suhrawardy, Dr. Satis Chandra Vidyabhusana, The Hon. Justice Sir Asutosh Mukhopadhyaya, Kt., Babu Nilmani Chakravarti, A. H. Harley, Esq., Aga Muhamad Kazim Shirazi, O. F. Jenkins, Esq., D. R. Bhandarkar, Esq., The Hon Mr. W. C. Wordsworth.

Hon. Numismatist.

Lieut.-Col. H. Nevill, I.C.S.

Hon. Joint Secretaries, Science Congress.

Prof. P. S. Macmahon.
Dr. J. L. Simonsen.

Mr. E. Vredenburg made the following exhibitions :—

1. A specimen of *Dolium zonatum* Green, with a supernumerary varix.

2. Specimens establishing the specific identity of *Dolium luteostoma* Küster with *Dolium variegatum* Lamarck.

3. Specimens establishing the specific identity of *Dolium magnificum* G. B. Sowerby (1904) with *Dolium chinense* Dillwyn.

Dr. Annandale exhibited a collection of molluscs from Seistan.

The following papers were read :—

1. *Influence of the five heretical Teachers on Jainism and Buddhism.—By* Bimala Charan Law.

2. *Ancient Hindu Spherical Astronomy.—By* G. R. Kaye.

3. *Identification of three Monuments at Sarnath.—By* Brindavan C. Bhattacharya.

These three papers have been published in the *Journal.*

The President announced that there would be no meeting of the Medical Section this month.

◆

APRIL, 1919.

The Monthly General Meeting of the Society was held on Wednesday, the 2nd April, 1919, at 9-15 p.m.

Dr. Satis Chandra Vidhyabhusana, M.A., in the chair.

The following members were present :—

Dr. P. J. Brühl, Dr. B. L. Chowdhuri, Dr. W. A. K. Christie, Mr. Hem Chandra Das-Gupta, Mr. S. W. Kemp, Dr. L. L. Fermor, Dr. G. E. Pilgrim, Mr. E. Vredenburg, Mr. H. Walker.

The minutes of the last meeting were read and confirmed.

Fifty-six presentations were announced.

The General Secretary reported that Babu Dwarkanath Chakravarti had expressed a desire to withdraw from the Society.

The Secretary announced that it was proposed to hold an Exhibition at Howrah from the 19th to the 27th April, 1919, in connection with the 12th sitting of the Bengal Literary Conference.

The following four gentlemen were balloted for as ordinary members :—

Mr. R. Friel, I.C.S., Inglesby, Shillong, proposed by Mr. S. W. Kemp, seconded by Dr. N. Annandale ; *Mr. A. Sen,* M.A., Bar.-at-Law, University Lecturer, 80, Lower Circular Road, Calcutta, proposed by Dr. B. L. Chaudhuri, seconded by Dr. Satis Chandra Vidyabhusana ; *Mr. S. N. Bal,* Assistant Professor of Botany, Calcutta University, 35, Ballygunge Circular Road, Calcutta, proposed by Dr. P. J. Brühl, seconded by the Hon. Justice Sir Asutosh Mukhopadhyaya ; *Babu Panchanan Mitra,* M.A., Professor, Bangabasi Collage, 116, Raja Rajendralal Mitra Road, Calcutta, proposed by Dr. Satis Chandra Vidyabhusana, seconded by Mr. Hem Chandra Das-Gupta.

The following papers were read :—

1. *Fire Walking in South India.—By* L. K. ANANTHAKRISHNA IYER. *Communicated by the Anthropological Secretary.*

2. *Observations on the intra-uterine Embryos of Elasmobranchs.—By* T. SOUTHWELL *and* B. PRASHAD.

This paper has been published in the *Journal.*

3. *Notes on Vallisneria.—By* L. KENOYER. *Communicated by* DR. SIMONSEN.

This paper will be published in a subsequent number of the *Journal.*

4. *The Oculus in Boat Decoration.—By* J. HORNELL. *Communicated by* DR. SIMONSEN.

This paper will be published in the *Memoirs.*

5. *Suggestions concerning the History of the Drainage of Northern India arising out of a study of the Siwalik Boulder Conglomerates.—By* G. E. PILGRIM.

This paper has been published in the *Journal.*

6. *The Territorial System of the Rajput Kingdoms of Mediæval Chhattisgarh.*—*By* C. U. WILLS. *Communicated by* DR. N. ANNANDALE.

This paper has been published in the *Journal.*

7. *Indian Books bought monthly by the Jesuits for the Library of Louis XV of France* (1729–1737).—*By* H. HOSTEN.

The Chairman announced that there would be no meeting of the Medical Section during the month.

◆

MAY, 1919.

The Monthly General Meeting of the Society was held on Wednesday, the 7th May, 1919, at 9-15 P.M.

MAHAMAHOPADHYAYA HARAPRASAD SHASTRI, C.I.E., M.A., F.A.S.B., President, in the chair.

The following members were present:—

Dr. N. Annandale, Miss M. L. Cleghorn, Dr. L. L. Fermor, Mr. H. G. Graves, Mr. S W. Kemp, Capt. R. B. Seymour Sewell, I.M.S., Dr. Satis Chandra Vidyabhusana, Mr. H. Walker, Mr. E. Vredenburg.

Visitors:—Mr. S. N. Bal, Mr. C. Cleghorn, Miss O. Cleghorn, Mr. J. Hornell.

The minutes of the last meeting were read and confirmed.

Twenty-three presentations were announced.

The General Secretary reported that Mr. E. H. Walsh, Mr. C. A. Story and Babu Prokash Chandra Mitra had expressed a desire to withdraw from the Society.

The General Secretary reported that Dr. E. H. Hankin whose name was removed from the member-list under rule 38 wished to be reinstated under rule 39.
Carried unanimously.

The President announced that Babu Birendra Nath Basu Takur, Mr. H. D. Graves Law, I.C.S., and Pandit Ram Swarup Khausala, being largely in arrears with their subscriptions, had been declared defaulters and that their names would be posted in accordance with Rule 38.

The following three gentlemen were balloted for as ordinary members:—

Mr. C. U. Wills, I.C.S., Nagpur, proposed by Dr. N. Annandale, seconded by Capt. R. B. Seymour Sewell, I.M.S.;

Dr. Winfield Dudgeon, Professor of Botany, Ewing Christian College, Allahabad, proposed by Dr. N. Annandale, seconded by Dr. W. A. K. Christie; *Babu Kamakhya Dat Ram*, Zemindar, 21, Clyde Road, Lucknow, proposed by Mr. R. Burn, seconded by Raja Kushal Pal Singh.

The following papers were read :—

1. *Notes on the Vegetation of Seistan.—By* N. ANNANDALE *and* H. G. CARTER.

2. *A Progress Report on the Work done during the year* 1918 *in connection with the Bardic and Historical Survey of Rajputana.—By* L. P. TESSITORI.

This paper will be published in a subsequent number of the *Journal*.

The President announced that there would be no meeting of the Medical Section during the month.

◆

JUNE, 1919.

The Monthly General Meeting of the Society was held on Wednesday, the 4th June, 1919, at 9-15 P.M.

P. J. BRÜHL, Esq., I.S.O., D.Sc , F.C.S., F.G.S., F.A.S.B., in the chair.

The following members were present :—

Dr. N. Annandale, Miss M. L. Cleghorn, Mr. H. G. Graves, Babu Sasadhar Roy, Capt. R. B. Seymour Sewell, I.M.S., Dr. Satis Chandra Vidyabhusana.

Visitors :— Mr. C. Cleghorn, Miss O. Cleghorn.

The minutes of the last meeting were read and confirmed.

Twenty-two presentations were announced.

The Chairman announced that in accordance with Rule 38, the names of Babu Birendra Nath Basu Thakur of Dacca, Mr. H. D. Graves Law, I.C.S., and Pandit Ram Swarup Khansala of Ambala Dist., had been posted as defaulting members since the last meeting and their names had now been removed from the member list.

The following gentlemen were balloted for as ordinary members :—

Mr. C. F. H. Tacchella, Indian Institute of Science, Bangalore, proposed by Mr. S. W. Kemp, seconded by Dr. W. A. K. Christie; *Dr. Amulya Chandra Mitra*, Medical Practitioner, Burdwan, proposed by Sir P. C. Ray, Kt., seconded by Dr. W. A. K. Christie, *Mr. George Matthai*, M.A., Indian Educational Service, Professor of Zoology, Government College, Lahore, proposed by Dr. N. Annandale, seconded by Dr. W. A. K. Christie; *Dr. Ajit Mohan Bose*, M.B., Ch.B. (Edin.), Physician, 191/1, Bowbazar Street, Calcutta, proposed by Dr. K. S. Ray, seconded by Dr. B. L. Chaudhuri.

Dr. Annandale exhibited (1) a Naga weighing beam of the bismer type; (2) photographs and models illustrating the use of reeds among the lake people of Hamun-i-Helmand in Seistan; (3) photographs of a primitive loom used by the Gaodar tribe in Seistan.

The Philological Secretary exhibited prints of two plates illustrating a paper on the coins of the Jajapella dynasty, by Mr. R. D. Banerji.

The reading of the following papers was postponed :—

1. *Interaction of phosphorus halides and arsenious and arsenic compounds.—By* NAGENDRA NATH SEN. *Communicated by the Physical Science Secretary.*

2. *Some new Species of Plants from Behar and Orissa.—By* H. H. HAINES.

3. *Notes on the Panchet reptile.—By* HEM CHANDRA DAS-GUPTA.

4. *Note on a mammalian fossil fron Bhavanagar (Kathiawar).—By* HEM CHANDRA DAS-GUPTA.

The Chairman announced that there would be no meeting of the Medical Section during the month.

PRINCIPAL PUBLICATIONS OF THE SOCIETY.

Asiatic Researches, Vols. I—XX and Index, 1788—1839.
Proceedings, 1865—1904 (now amalgamated with Journal).
Memoirs, Vol. 1, *etc.*, 1905, *etc.*
Journal, Vols. 1—73, 1832—1904.
Journal and Proceedings [*N. S.*], Vol. 1, *etc.*, 1905, *etc.*
Centenary Review, 1784—1883.
Bibliotheca Indica, 1848, *etc.*

A complete list of publications sold by the Society can be obtained by application to the Honorary Secretary, 1, Park Street, Calcutta.

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(*a*) To be present and vote at all General Meetings, which are held on the first Wednesday in each month except in September and October.

(*b*) To propose and second candidates for Ordinary Membership.

(*c*) To introduce visitors at the Ordinary General Meetings and to the grounds and public rooms of the Society during the hours they are open to members.

(*d*) To have personal access to the Library and other public rooms of the Society, and to examine its collections.

(*e*) To take out books, plates and manuscripts from the Library.

(*f*) To receive *gratis*, copies of the *Journal and Proceedings* and *Memoirs* of the Society.

(*g*) To fill any office in the Society on being duly elected thereto.

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List of Officers and Members of Council

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17. Notes on Vallisneria.

By L. A. Kenoyer, Ph.D., *Allahabad School of Agriculture.*

While collecting aquatic plants at Allahabad two years ago, the author's attention was drawn to a miniature *Vallisneria* which grows near the edge of several of our lakes. It has leaves 2 to 4 inches long, a pistillate scape 6 to 12 inches long, and grows at a depth of less than a foot. After flowering the capsule very rapidly elongates, ultimately becoming about 60 by 2 mm. There also commonly occurs a much larger form in water 4 to 8 feet in depth. This has leaves 2 to 4 feet long, a pistillate blossom twice as thick and somewhat longer than that of the former, a much longer and thicker pistillate scape and a capsule about 40 × 6 mm. In all other characters they are similar. *Vallisneria spiralis*, L., is described as a cosmopolitan and very variable species. One would think these two plants represent the extreme size forms of this species, and are a reaction to the different depths of the water were it not for the fact that there are no intermediate forms in the same waters, and that whereas some lakes contain both forms, others contain only the one or the other.

In one of the lakes near Gwalior the larger of the above forms was seen. But in the flowing water of the Morar River are two other forms. So far as size of the plant is concerned, both these forms are intermediate to the first described. One has fruits very narrow, and more elongated than those of the Allahabad small form. In places where the water level had become lowered the tips of these fruits were drying and dying while the basal portion remained alive to mature its seeds. The other form has pods thicker, slightly curved, and somewhat enlarged toward the tip.

Material of the Indian *Vallisneria* forms has been sent to Dr. Robert B. Wylie of the Iowa State University, U.S.A. In a recent paper (The Pollination of *Vallisneria spiralis*. The Botanical Gazette 63 : 2, February 1917) he points out several differences between the Iowa form and the form described in Kerner's classical figure. If Kerner's drawing is reasonably accurate and the differences between the European and the American *Vallisneria spiralis* are real, the Indian plants, which may be grouped together for this comparison, exhibit striking differences from either. Those differences may be summed up in the accompanying table.

European form (*Kerner*).	*American form* (*Wylie*).	*Indian forms.*
No hairs on sepals.	Hairs on base of staminate sepals.	No hairs on sepals.
Stamens widely diverging.	Stamens closely approximate.	Stamens very widely diverging.
Stam. fls. 1/4 diameter of pistillate.	Stam. fls. 1/6 diameter of pistillate.	Stam. fls. 1/6 diameter of pistillate.
Spathe only at base of ovary.	Spathe almost covering ovary.	Spathe about half way up ovary.
Pistillate sepals acute, straight.	Pistillate sepals obtuse, inarched.	Pistillate sepals very obtuse, nearly straight.
Diameter of ovary ·15 spread of stigmas.	Diameter of ovary ·5 spread of stigmas.	Diameter of ovary ·6 spread of stigmas.
Stigmas projecting above surface of water.	Stigmas on surface of water.	Stigmas on surface of water.
Stigmas fringed.	Stigmas not fringed, flexible and recoiled.	Stigmas not fringed, rather stiff, arched but not coiled.

It appears most probable that what has been known as *Vallisneria spiralis* contains a number of species and varieties, separated by wide local variations and still wider continental variations. It is to stimulate the investigation of the characters of this interesting genus in India that this brief paper has been presented.

18. On the Rationalisation of Algebraic Equations.

By Nripendra Nath Chatterjee.

(Read on 3rd September, 1919.)

Before 1908 I had contributed a few papers on more than one method of rationalising algebraic equations. In 1908 a paper on the same subject by the late Prof. Mahendranath De appeared in the Journal of this Society for the month of July. I must take this opportunity of expressing my indebtedness to Rai Abinashchandra Bose Bahadur, Controller of Examinations, Calcutta University, for his kindness in drawing my attention to this paper.

I am glad to find that Prof. De, having compared the different methods of renowned mathematicians, e.g. Prof. Sylvester, Prof Cayley, Capt. MacMahon and others, was good enough to pronounce my method as the most general one for the rationalisation of algebraic equations. But he took exception to my method, as not leading to the equation in the lowest degree. I am afraid he missed one of my other methods in which it was shown that the equation obtained was always in the lowest degree.

This evening I intend to present the Society with a novel method—which might with propriety be termed the "method of indeterminate coefficients." Although the method of indeterminate coefficients has been applied to various other problems, it is believed that this method has not as yet found any application to the rationalisation of algebraic equations.

I. Let the equation be:

$$x = f(p^{\frac{1}{n}}), \quad (p^{\frac{1}{n}} \text{ not rational})$$

which can always be put under the form

$$x = A_0 + A_1 p^{\frac{1}{n}} + A_2 p^{\frac{2}{n}} + \ldots\ldots\ldots\ldots + A_{n-1} p^{\frac{n-1}{n}},$$

where $A_0, A_1, A_2, \ldots\ldots$ are rational.

If $y = x - A_0$, we have

$$P_1 y = P_1 A_1 p^{\frac{1}{n}} + P_1 A_2 p^{\frac{2}{n}} + \ldots\ldots\ldots + P_1 A_{n-1} p^{\frac{n-1}{n}}, \qquad \text{(i)}$$

$$P_2 y^2 = P_2 B_0 + P_2 B_1 p^{\frac{1}{n}} + \ldots\ldots\ldots + P_2 B_{n-1} p^{\frac{n-1}{n}}, \qquad \text{(ii)}$$

(where $B_0, B_1, \ldots\ldots B_{n-1}$ are rational functions of p, A_1 $A_2, \ldots\ldots$).

. . . .

$$P_{n-1} y^{n-1} = P_{n-1} V_0 + P_{n-1} V_1 p^{\frac{1}{n}} + \quad \ldots\ldots \quad + P_{n-1} V_{n-1} p^{\frac{n-1}{n}}$$

$$\ldots\ldots\ldots\ldots\ldots\ldots \quad (n-1)$$

$$y^n = W_0 + W_1 p^{\frac{1}{n}} + \quad \ldots\ldots \quad W_{n-1} p^{\frac{n-1}{n}}$$

$$\ldots\ldots\ldots\ldots\ldots\ldots \quad (n)$$

$P_1, P_2, P_3, \ldots\ldots P_{n-1}$ being as yet undetermined.

Adding the above equations we get

$$y^n + P_{n-1} y^{n-1} + \ldots\ldots + P_1 y$$
$$= W_0 + P_{n-1} V_0 + \ldots\ldots\ldots + P_2 B_0 \qquad (A)$$

if
$$W_1 + P_{n-1} V_1 + \quad \ldots\ldots \quad + P_2 B_1 + P_1 A_1 = 0 \qquad (1)$$
$$W_2 + P_{n-1} V_2 + \quad \ldots\ldots \quad + P_2 B_2 + P_1 A_2 = 0 \qquad (2)$$

. . . .

$$W_{n-1} + P_{n-1} V_{n-1} + \ldots\ldots + P_2 B_{n-1} + P_1 A_{n-1} = 0 \qquad (n-1)$$

which equations are sufficient for the unique determination of the values of $P_1, P_2, \ldots\ldots P_{n-1}$. Substituting these values in (A) and remembering $y = x - A_0$, we get the rationalised equation in x, which is of the n^{th} degree only.

II. Let the equation be:

$$x = f\left(p^{\frac{1}{m}},\ q^{\frac{1}{m}}\right),$$

which can also be written under the form:

$$x = A_0 + \left(A_1 p^{\frac{1}{m}} + A_2 q^{\frac{1}{m}}\right) + \left(B_1 p^{\frac{2}{m}} + B_2 p^{\frac{1}{m}} q^{\frac{1}{m}} + B_3 q^{\frac{2}{m}}\right)$$
$$+ \ldots + W_1 p^{\frac{m-1}{m}} q^{\frac{m-1}{m}},$$

the right-hand side containing m^2 terms. By following the same method as before we get the rationalised algebraic equation of the m^2th degree.

III. Let the equation be:

$$x = f\left(p^{\frac{1}{l}},\ q^{\frac{1}{m}},\ r^{\frac{1}{n}},\ \ldots\right).$$

Every integral function of $p^{\frac{1}{l}}, q^{\frac{1}{m}}, r^{\frac{1}{n}}, \ldots$, where $l, m, n, \ldots$ are integers, can be expressed as a linear function of $p^{\frac{1}{l}}, p^{\frac{2}{l}}, p^{\frac{3}{l}}, \ldots\ldots p^{\frac{l-1}{l}}; q^{\frac{1}{m}}, q^{\frac{2}{m}}, \ldots q^{\frac{m-1}{m}}; r^{\frac{1}{n}}, r^{\frac{2}{r}}, \ldots r^{\frac{n-1}{n}}$; etc., and their products taken 2, 3, etc. at a time. Thus the right-hand side of the equation consists of

$$\begin{aligned}&1+\{(l-1)\quad+(m-1)+\dots\dots\}\\&\quad+\{(l-1)(m-1)+\quad\dots\dots\dots\}\\&\quad\dots\dots\dots\dots\dots\dots\dots\\&\quad+\ (l-1)(m-1)\dots\dots(n-1)\end{aligned}$$

terms, i.e. $(l.m.n.\ \dots\dots)$ terms. Therefore in this case also the previous method is effective in giving the rationalised equation of the $(l.m.n.\ \dots)$th degree.

In case I, the degree of the equation cannot be less than n, for if

$$x=f(p^{\frac{1}{n}})$$

is a root, so will also be

$$x=f(\theta p^{\frac{1}{n}})$$

where $\theta^n=1.$

In case II, the degree of the equation will be m^2, for if

$$x=f(p^{\frac{1}{m}},\ q^{\frac{1}{m}})$$

is a root, so will also be

$$x=f(\theta_1 p^{\frac{1}{m}},\ \theta_2 q^{\frac{1}{m}}),$$

where $\theta_1^{\ m}=1,\ \theta_2^{\ m}=1.$

In case III, the different roots are similarly given by the $l.m.n.\dots$ expressions

$$x=f(\theta_1 p^{\frac{1}{l}},\ \theta_2 q^{\frac{1}{m}},\ \theta_3 r^{\frac{1}{n}},\ \dots)$$

where $\theta_1^{\ l}=1,\ \theta_2^{\ m}=1,\ \theta_3^{\ n}=1,\quad\dots$

and thus the degree of the equation in this case will certainly be $l.m.n.\dots$

यह पुस्तक वितरित न की जाय
NOT TO BE ISSUED

19. Some New Species of Plants from Behar and Orissa.

By H. H. Haines.

(With Plates IX—XI.)

During my tours in the province of Behar and Orissa I have been studying the flora as far as more pressing duties have permitted. Among a very large number of plants not previously recorded from that province, certainly not less than a hundred and possibly a great many more, I have found a few which appear not to have been hitherto described and from among these I have selected a dozen and given their descriptions below. They have been named by me as follows :—

Hypericum Gaitii.
Aglaia Haslettiana.
Atylosia cajanifolia.
Mucuna minima.
Jussieua fissendocarpa.
Pimpinella bracteata.
Ligusticum alboalatum.
Melothria zehnerioides.
Oldenlandia arenaria.
Lobelia aligera.
Thesium unicaule.
Tragia Gagei.

The *Hypericum* is a very handsome plant and was obtained from the high plateau on which Neterhat is situated. Neterhat is getting to be well known to many people in Bihar and Orissa who have been enabled by Sir Edward Gait, a fellow of this Society, to spend part of the hot weather in its cool breezes, and I have thought it appropriate to name this species after him. It is closely allied to and intermediate between *Hypericum cernuum* and *Hypericum mysorensis*, a Himalayan and South Indian mountain species respectively, but unless these two species are united it is also necessary to keep the Neterhat species distinct. The little *Lobelia*, the two Umbellifers and the interesting little *Thesium* are also from the plateau. A third Umbellifer, tentatively called by me *Carum villosum*, may be a variety of Wallich's *Carum anethifolium* and is therefore not described pending further comparison with material at Kew. This plant was obtained from the Sameshwar Hills in North Champaran which yielded me a large number of other interesting plants.

यह पुस्तक वितरित न की जाय
NOT TO BE ISSUED

In addition to the species already mentioned from the Neterhat plateau and its vicinity there are found there a true Buttercup (*Ranunculus pensylvanicus*), a yellow Raspberry (*Rubus molluccanus*), two Potentillas, the little *Geranium ocellatum* which is also found on the top of Parasnath, and many other interesting plants. I would urge therefore that every endeavour be made to potect this interesting local Flora, which occurs especially along streams and which would be liable to extermination if Neterhat becomes a large hill-station. The *Thesium*, of which we have also a representative in the British Isles, is a little very slender plant growing among grass and is therefore apt to be passed over. In descriptions of this genus (Thesium) I can find no mention of the peculiar filling up of the ovarian cavity with a jelly-like mass or a very thin-walled tissue. This is not referred to, either, in the excellent account of the very numerous Cape Thesiums by A. W. Hill published in the Kew Bulletin (1915). Whether it is peculiar to *Thesium unicaule* I am unable to say. The point is difficult to determine from dried material, but judging from the delicacy of the ascending spiral thread on which the minute ovules are borne I expect that it is general as the thread could hardly be self-supporting in a free cavity. This ovarian substance probably accounts for the extraordinarily rapid development of the seed after pollination: one flower being very young with the ovules scarcely visible when the next older has a large seed filled with white albumen, probably perisperm.

Jussieua fissendocarpa was found in ditches in Purneah near the Nepal frontier. The curious dimorphism of the seeds has not before been noticed in the genus nor has the fissible endocarp, though a similarly corky endocarp has, as noted in the detailed description of the species, been observed in *Jussieua affinis*. *Jussieua fissendocarpa* appears to be represented already in the Calcutta Herbarium in a specimen collected in Perak but named *Ludwigia prostrata*, an entirely different plant. The species does, however, approach *Ludwigia* by the more or less complete reduction of the second whorl of stamens, and on all these characters some botanists would perhaps make a new genus. As it occurs in Purneah and Perak it may be expected to be found throughout the Eastern Peninsula and has probably been passed over from its superficial resemblance to *Jussieua suffruticosa*.

The Atylosia has been called 'wild Arhar' by the people in Orissa and has an extraordinary general resemblance to it. I would like to have called it 'Atylosia cajanoides' as it is *not only* in the leaf that this resemblance occurs, but that name is occupied by a Madagascar plant.

Mucuna minima is very exceptional in its genus from the remarkably small flowers and few-flowered inflorescence. Such small flowers can only be found among some of the American cultivated varieties. Having much other work to attend to when I first observed this little plant, I had unfortunately no time to collect more than a single specimen. This solitary one has been deposited in the Calcutta Herbarium with specimens of the other plants here described. The fruit is still unknown and the plant should be looked for in grass glades in the Sambalpur, Bamra and Rairakhol forests. It probably extends its distribution into Madras.

Aglaia Haslettiana is a tree of which the fruit still remains to be collected and *Oldenlandia arenaria* is a little plant found in the sands of the Orissa coast.

One of the most interesting little plants in the province which I at first included in this list is a species of *Lawia*, better known by the name *Terniola* subsequently given to the genus. It is found adhering to gneiss rocks in rivers in Angul and is periodically covered by water. I described it under the name of Lawia bengalensis, but after a perusal of Willis's account of the Podestomonaceae of India and Ceylon in which he amalgamates all the known Ceylon and Indian species into one, *Lawia zeylanicum*, a somewhat refreshing change to the usual hair-splitting tendencies of the present day, I think the Angul plant should certainly be included in that species also. It differs by its exceedingly minute leaves and the absence of ribs on the capsule. Willis, however, points out the excessive variability of the size of the leaves, and as the ribs are represented by delicate nerves, the differences are not sufficient to separate it. Hitherto, excepting two species from Indo-China I have found no record of a *Terniola* except in Ceylon and on the western side of India.

The photographs being taken from dried specimens are not in all cases very clear.

1. **Hypericum Gaitii**, *Haines* (Hypericaceae). Pl. X.

H. cernuo Roxb. et H. mysorensi, Heyne valde propinquum. Ab H. cernuo oblongis foliis angustioribus magis punctatis, capsulis longioribus acuminatisque, sepalis majoribus lanceolatis vel oblongis haud ovatis et stylis ovario non duplo-longioribus differt. Ab H. mysorense ramulis teretibus nec quadrangularibus, foliis majoribus neque confertis petalis obovatis stylis ovario non duplo-longioribus et capsula majore distinguitur.

Frutex speciosus ramosus 3-5 ped. altus ramulis teretibus. Folia opposita sub-amplexicaulia glauca ell.-oblonga, oblongo-lanceolata vel oblongo-oblanceolata, pellucido-punctata 5-6·5 cm. longa; nervi laterales 2-3 prope basim rotundatam utrinque positi apicem versus multo procurrentes, subparalleli. Cymae brevissimae 3-7- (interdum 1-) florae saepe 3-chotomae. Flores clarissime-flavi 2-6·5 cm. lati. Sepala 7·8-12·7 mm.

longa ovato-lanceolata vel oblongo-lanceolata. Petala obovata 2·5-3 cm. longa 2-2·3 cm. lata. Stamina 1·25-1·8 cm. longa. Styli ovario 12-13 mm. longiores, hoc 7-8 mm. Capsula circiter 18 mm. longa. Semina 1 mm. longa linearia teretia brunnea nitentia.

Sub-tropical India. On the plateau ('pats') of Chota Nagpur, elev. 3,000 ft., along rivers.

Both in characters and distribution this species connects the Himalayan H. cernum and the South Indian H. mysorense. It is named after Sir A. Edward Gait, Lieut.-Governor of Bihar and Orissa.

2. **Aglaia Haslettiana,** *Haines* (Meliaceae-Trichilieae). Pl. IX.

Species distincta, generi Amoorae valde affinis nec, in hac re, fructu ignoto, genus certe distinguitur.

Arbor mediocris 10-13 m. alta et 90-120 cm. (3-4 ped.) trunci ambitu, ramulis dense lepidotis. Folia usque ad 40 cm. longa imparipinnata vel rariore paripinnata; foliola 5-7 plerumque alterna, 15 cm.-22 cm. longa, 3·5-7·5 cm. lata infimis foliolis autem parvioribus, oblonga vel oblongo-ellliptica vel paullo oblanceolata, apice subito acuminata, basi cuneata interdum inaequalia, juventute utrinque dense lepidota postea plus minus glabrescentia praeter nervos; nervi laterales 10-15 conspicui recti nisi prope marginem qua arcuati, reticulatione obscura; petioli ·3-1 cm longi. Inflorescentia axillaris 5 cm.-10 cm. longa paniculata dense lepidota pedunculis brevissimis ramis ramulisque rigidis; flores fasciculati fragrantissimi 2 mm. diametro pedicellis 1-1·5 mm. longis. Calyx late-campanulatus lepidotus, lobis brevibus obtusis. Petala 5 oblonga 1·5-2 mm. longa apice rotundata. Tubus stamineus globosus petalis aequilongus, ore leviter crenulatus, intus 10 lineis prominulis decurrentibus ornatus. Antherae 10 in linearum apicibus positae sessiles inclusae oblongae. Discus 0. Ovarium leviter 3-angulare stigmate sessile 3-lobo.

India. Orissa, in the districts of Angul and Puri! Flowers April-May.

The species is named after Mr. Haslett of the Indian Forest Department.

3. **Atylosia cajanifolia,** *Haines* (Papilionaceae-Phaseoleae). Pl. IX.

Species distincta, habitu foliisque A. lineatae inflorescentia fructuque A. niveae quodammodo attinget.

Frutex erectus 3-6 ped altus facie Cajani indici ferente, caule leviter augulato minute pubescente. Folia sub-digitata. Petiola 1·2-4 cm. longa. Foliola rhomboideo-lanceolata acutissima, inferioria 4-8 cm. superioria saepe sola 12 mm. longa, supra minute pubescentia subtus pallida sub-tomentosa, margine crassata, basi trinervia; nervi laterales utrinque circa 4, nervulis reticulatis. Stipellae 0. Pedunculi foliis longiores axillares 2-5 cm. longi. Flores 1-4 plerumque 2 ad extremas pedunculorum. Calyx circa 4 mm. longus, dentes triangulares tubo duplo-triplo minores corolla 11-13 mm. longa nonnunquam marcescens fusco-fulva vexillo in tergo purpureo-venoso. Legumen minute velutinum 25-33 mm. longum 10 mm. latum profunde striatum inter semina. Semina 4-6 atra nitentia 4 mm. longa strophiolo magno.

India. Forests of Orissa! Called Ban Arhar by the Oriyas and looks very like Cajanus indicus (Arhar).

4. **Mucuna minima**, *Haines*. (Leguminosae-Papilionaceae Phaseoleae). Pl. X.

Species distincta, sed flores parvuli quodammodo ad eos Stizolobii Deeringiani (Piper) accedunt.

Herba gracilis volubilis caule sulcato sparse piloso. Folia parva: petiolum 2·5-3·8 cm. longum. Foliola utrinque sericea apicibus rotundatis, foliolum extremum late ellipticum v. obovatum 2·5-4 cm. longum, lateralia quam extremo majoria valde inaequaliter dimidiata parte dimidio infero gibboso, nervi secondarii 3-4. Stipellae filiformes. Flores purpurascentes ad rhachin nodiformam axillarem pauci conferti 2 cm. longi. Calyx dense sericeus 1 cm. longus secus lobum lanceolatum anteriorem mensus. Vexillum late-ovatum 1·4 cm. longum. Alae angustiore-oblongae 1·8 cm. leviter sericeae. Carina 1·9-2 cm. longa. Antherarum dorsifixarum filamenta superne tumida. Ovarium lineare stylusque dense pilosum. Ovula 2 (-1 ?). Fructus non videtur.

India. Sambalpur district, in grassy forest!

5. **Jussieua fissendocarpa**, *Haines* (Onagraceae). Pl. IX.

Species distincta sed J. affinis DC. fructu accedit. Ab J. suffruticosa floribus fructu seminibus differt, ab J. repente his characteribus etiam habitu differt.

Suffrutex ramosus caule 3-4 ped. alto tenacissimo ramis angulatis. Folia lanceolata v. lineari-lanceolata acuta subsessilia fere glabra circa (inferis decassis) 2-3 cm. longa basi rotundata. Flores solitarii ad omnes axillas. Sepala lanceolata 2·2 mm. Petala sepalis minora v. obsoleta. Stamina 8 quorum 4 parviora v. minima. Ovarium 4-costatum. Capsula teres 1·5-2·2 cm. longa minute pubescens, parte inferiore endocarpio suberoso transverse-fissidente instructo quoque segmente demum 2-valve. Semina ellipsoidea sub-compressa rapha prominente in cujusque loculi superiore parte multiseriata ·07 mm. longa, in inferiore parte uni-seriata majora, quoque intra endocarpii segmentum 2-valve incluso; seminorum parvorum axibus axi capsulae perpendicularibus v. obliquis, seminorum majorum axibus axi capsulae parallelibus

India, in ditches, northern Purnea and Nepal! Malay Peninsular (Perak) Curtis No. 3183!

It is possibly a widely distributed species which has been mistaken for J. suffruticosa to which it bears a superficial resemblance. The Malay specimen was named Ludwigia prostrata but with the remark "can it be!"

There is a very similar plant in the Calcutta Herbarium from Buitenzorg called "J. suffruticosa var." but this though with the same characteristic fruit and seed has different leaves and is probably J. linifolia Vahl. A figure of the seed of J. affinis DC. enclosed in its corky endocarp is given in Die Naturlich. Pflanzenfamilien (III 7, p. 207) but there is no mention there of its dehiscence The little corky cocci no doubt float on water, the valves opening when the seed begins to germinate, whereas the smaller free seeds would germinate in situ. The species with these peculiar fruits and dimorphous seeds seem to merit a special section of the genus which I propose to call Fissendocarpa.

6. **Pimpinella bracteata,** *Haines* (Umbelliferae-Ammineae).

Species P. diversifoliae DC. affinis sed habitu (minus ramoso) bracteis plerisque facile distinguenda.

Herba biennis 3-4 ped alta superne ramosa. Folia radicalia caulinaque inferiora pinnatim 3-5-foliolata 15-20 cm. longa petiolo incluso, rhachis villosa; foliola anguste v. late ovata crenata v. serrata utrinque pubescentia v. hispidula praecipue ad nervos, basi obtusa v. recta v. rariore subcordata, foliolorum lateralium basis maxime obliqua gibbosa; foliorum superiorum foliola lanceolata inciso-serrata, folia summa pinnatifida, lobis lineare-lanceolatis apicibus sub-spinulosis. Pedunculi terminali foliisque oppositi, sub-anthesin 3·5 cm. usque ad 8 cm. sub fructu, pubescentes. Umbellae 2·5-5 cm. diametro, bracteae 6 lineares 5-12 mm. longae, radii 8-12 pubescentes 12-20 mm. longi, bracteolae 3-5 lineares 2·5-5 mm. longae. Flores 2-2 5 mm. diametro. Fructus papillosus glabrescens.

India. Mountains of Chota Nagpur, 2,000–3,000 ft.!

7. **Ligusticum alboalatum,** *Haines* (Umbelliferae-Seselineae-Selineae). Pl. XI.

Species L. Thomsoni *Clarke* et L. marginatae *Clarke* affinis. Ab eis differt caulibus robustioribus plus sulcatis, foliis majoribus 2-pinnatis, foliorum caulinorum lobis angustioribus, fructu majore elliptico a dorso compresso (L. marginati fructus orbicularis, L. Thomsoni fructus est teres) bracteolis angustioribus quam pedicellis fructiferis multo brevioribus, alis jugorum majoribus.

Herba biennis 3-4 ped alta. Radix magna fusiformis. Caules fistulosi sulcati infra umbellas pubescentes. Folia paene glabra radicalia longe petiolata petiolo incluso usque ad

20-25 cm. vel annotina 60-80 cm. longa 20 cm. lata 2-pinnata, pinnae 5-8-jugae 2·5-10 cm. longae, pinnulae pinnatifidae vel inciso-serratae, lobi ultimi lineari-lanceolati, folia caulina pauca 2-pinnata v. pinnata v. pinnatifida ultimis lobis anguste-lanceolatis inciso-serratis v. linearibus apicibus subspinulosis. Umbellae 5-9 cm. diametro. Pedunculi longi. Bracteae involucri 0-2 lineares. Radii 18-25 hispiduli 18-32 mm. longi. Bracteae involucellorum circa 8-10 anguste-lineares inaequales. Pedicelli 20-30, 15-25 mm. longi v. 25-35 mm. fructu. Flores albi. Sepala 0. Petala 1·3 mm. obovata interne carinata apice inflexa. Antherae caeruleae. Fructus a dorso compressus 5 mm. longus 3·5-3·7 mm. latus, juga primaria in alas albas expansa, alae laterales dorsalibus duplo latiores, vittae ad valleculas dorsales saepe, 1 nunc 2 nunc 3 ad valleculas laterales 2-4, vittae commissurales usque ad 8 interdum interruptae. Semen leviter concavum.

India. Mountains of Chota Nagpur, elev. 2,500-3,000 ft., near streams. Fl. May. Fr. June.

8. **Melothria zehnerioides,** *Haines* (Cucurbitaceae-Cucumerineae). Pl. X.

Species M. odoratae Hf. & T. affinis, foliis alte 3-5-lobatis nervis petiolisque minus pubescentibus plus hispidis, floribus feminis cum masculis in racemis dispositis, connectivo antherae parvo neque dilatato neque producto, pedicellis in fructu robustioribus scabridis differt.

Herba scandens, ramis sulcatis parce hispidis. Folia alte 3-5-lobata, 6·5-8 cm. longa, marginibus nervisque hispidis et supra parce pilosis prope petiolum, lobis lanceolatis v. oblongis v. lineari-oblongis. Petiolus ·7-1·3 cm. longus hispidissimus. Flores monoeci albidi circa 7 mm. diametro ad nodos racemi angularis tenuis conferti masculis cum feminis, racemi 2·5-6·5 cm. longi, pedicelli 5-7 mm. longi hispidi. Calycis tubus campanulatus, sepala lineares, petala ovata acuta papillosa, antherae omnes 2-loculares, loculis fere rectis, connectivo neque producto neque lato neque lobato. Fructus 7·8-10 mm. subglobosus pedunculis tenuibus seminibus albidis compressis elliptico-obovatis 3·5 mm. longis.

India, in Purneah near the Nepal boundary.

9. **Oldenlandia arenaria,** *Haines* (Rubiaceae-Hedyotideae). Pl. XI.

Species O. umbellatae affinis, ramis robustioribus, stipulis integerrimis, sepalis latioribus brevioribus capsulis seminibusque majoribus differt.

Herba multis ramis diffusis striatis rigidis 10-20 cm. longis. Folia sessilia linearia ·8-2·3 cm. longa marginibus recurvatis, stipulis membranaceis truncatis sine setis. Flores minuti in cymas umbellatas sub-capitatas terminales et ad axillas superiores dispositi pedunculo foliis breviore, sepala lanceolata tubo corallae duplo breviora. Corolla infundibularis. Capsula late oblonga non didyma 3-3·7 mm. longa apice leviter supra hypanthium (calycis tubum) levata non autem quam sepalis longa. Semina pallide brunnea ellipsoidea obscure angulata.

India. On the sands of the Orissa coast. Fl. Fr. August-October.

10. **Lobelia aligera,** *Haines* (Campanulaceae-Lobelieae).

Species est sectionis Hemipogon, L. trialatae Ham. sectionis Holopogon dubie affinis, habitu antheris solum 2 apice barbatis foliis plerumque oblongis floribus majoribus sepalis lanceolatis differt.

Herba caulibus decumbentibus trialatis glabris 20-46 cm. longis. Folia 2-3 cm. longa elliptico-oblonga obtusa v. subacuta basi lata sessilia, supra glabra subtus paucis pilis ad nervos, marginibus serratis leviter crispatis. Pedicelli axillares foliis longiores. Calyx sparsim pilosus, Calycis tubus obconicus basi acutus lobi patentes anguste-lanceolati tubo longiores nempe 3 mm. longi. Corolla 5·5 mm. longa lataque, labii lobis lateralibus ovatis lobo medio oblongo emarginato, petalis superioribus oblongis appendice longa lineari pubescenti ornata. Antherae 2 anteriores apice barbatae posteriores marginibus ciliatae. Capsula obconica 5-5·5 mm. longa minute rostrata. Semina brunnea late-ellipsoidea vix compressa.

India. Mountains of Chota Nagpur, elev. 3,000 ft. near streams.

11. **Thesium unicaule,** *Haines* (Santalaceae). Pl. X.

Species T. himalensi, *Royle* et T. Wightiano affinis. Ab illo floribus cylindriacis sessilibus, bracteis (foliis subtendentibus) nunquam longo pedunculo adnatis nec spicatis, lobis perianthii parvioribus, foliis tenuioribus, stylo brevi differt. Ab hoc habitu unicauli erecto, floribus nunquam subterminalibus, bracteis longis et alteris characteribus differt.

Herba annua erecta 16-35 cm. alta caule tenui fastigiatim ramoso. Folia anguste-lineares usque ad 2·5 v. 3·5 cm. longa. Bracteae foliis omnino similes. Flores virides 3 mm. longi solitarii axillares intra 2 bracteolas lineares valde sessiles, bracteolis 2 mm. longis supra folii subtendentis basin proxime sitis, bractea pedunculo tenui neque adnata; floris lobi ·5 mm. oblongi marginibus albidis, in fructu lineari-oblongi incrassati. Antherae a dorsis lobis perianthii lobis pilorum barbula agglutinatae. Ovarium cum disco quam totem florem triplo brevius, ejus caverna tela expleta in qua placenta spiralis tenuissima ascendit. Ovula 1-3 nuda minutissima infra placentae

apicem sessilia. Fructus globosus v. ellipsoideus, siccate venosus. Embryo fusiformis.

India. Mountains of Chota Nagpur amongst grass.

The species does not appear to be parasitic on the grass roots. The ovule on fertilization develops very fast, absorbing the tissue in the ovarian cavity and replacing it with white perisperm.

12. **Tragia Gagei**, *Haines* (Euphorbiaceae-Crotoneae-Plukenetieae).

Species T. bicolori *Miquel* affinis, foliis oblongis fere glabrescentibus, bracteis ovatis parvis, sepalis fructiferis parvis nec strigosis differt.

Herba volubilis ramis brunneis leviter pilosis. Folia oblonga abrupte acuminata basi cordata margine dentata-serrata, 10-18 cm. longa, subtus fere glabra supra paucis setis munitis nervis praecipuis basi 5-7, nervis lateralibus circiter 3. Petiolus 3-4 cm. longus basi apicique leviter crassus, juventute villosus. Stipulae triangulares 1·8 mm. Bracteae ovatae 1-1·3 mm vel infra flores masculos quam 1 mm. minus, praeter margines paene glabrae. Maris sepala 4 oblonga acuta. Stamina 2 antheris latioribus quam longis. Feminae sepala fructifera 2-2·4 mm. longa oblongo-oblanceolata acuta integerrima extus puberula intus glabra. Capsula hispida 7-8 mm. seminibus globosis 5-5·5 mm. levissimis nec chalazae tumidis brunneo-albidis marmoratis.

India. Jungles of Orissa.

This species is scarcely stinging. The seed resembles that of T. bicolor but is larger and is altogether different from that of T. involucrata *L.*

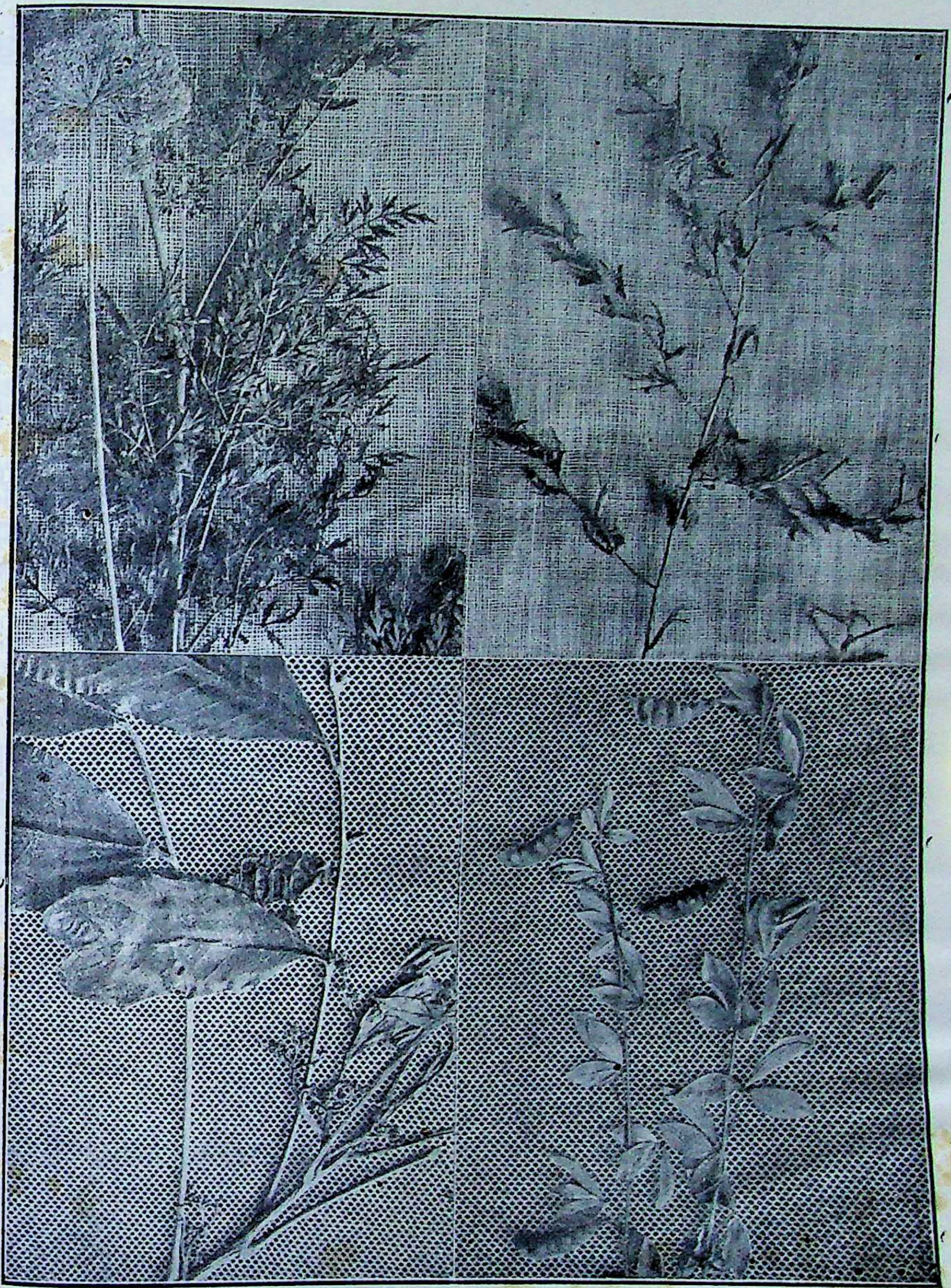
* * *

Jour. As. Soc. Beng. Vol. XV, 1919

Plate IX

Carum villosum

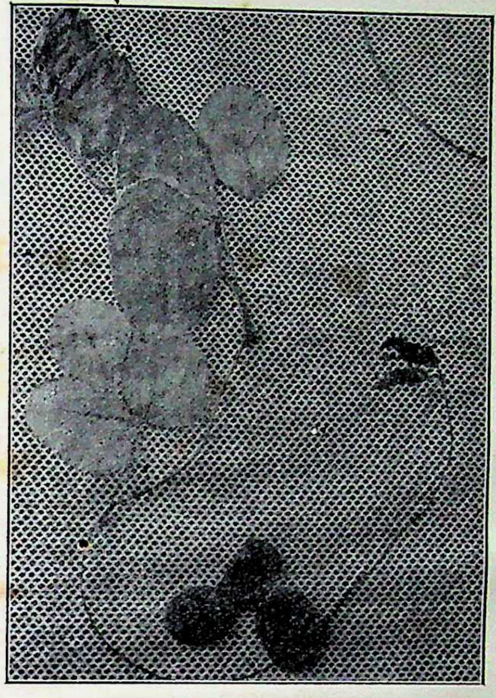
Jussiena fissendocarpa



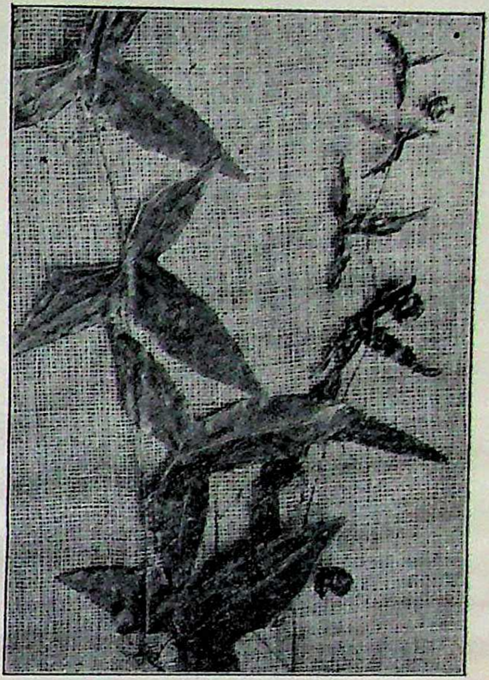
Aglaia Haslettiana

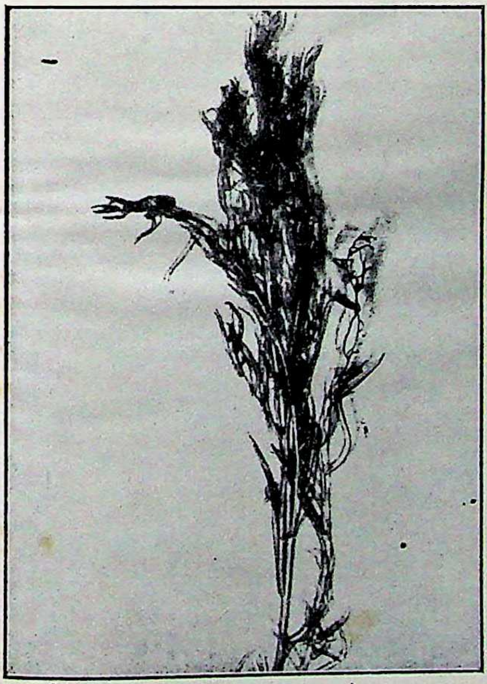
Atylosia cajanifolia

Macuna minima

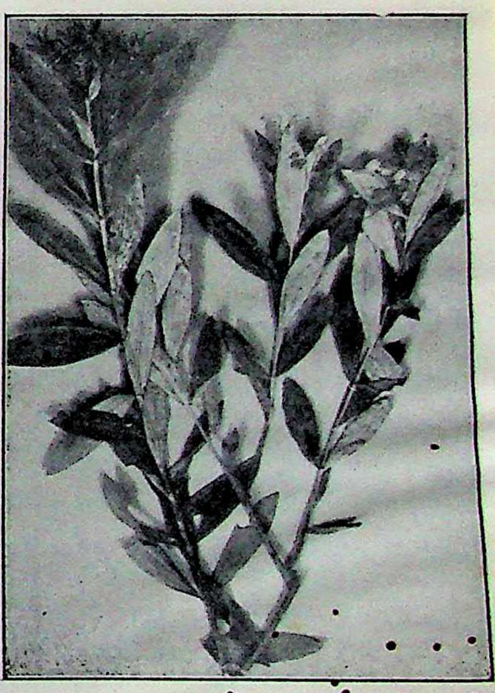


Melothria zehnerioides

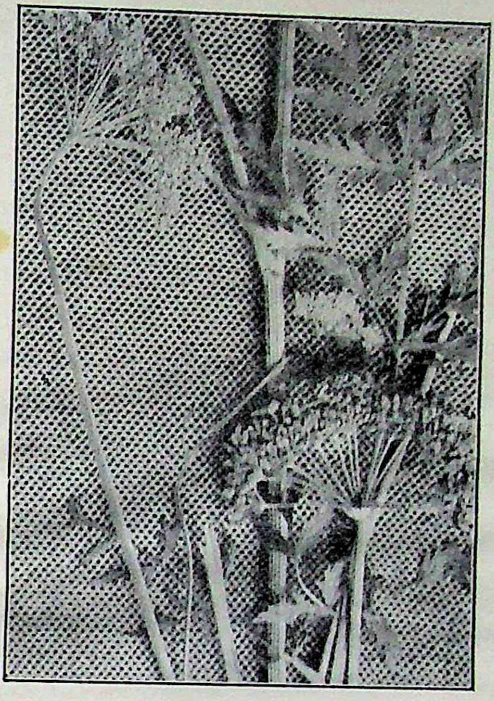




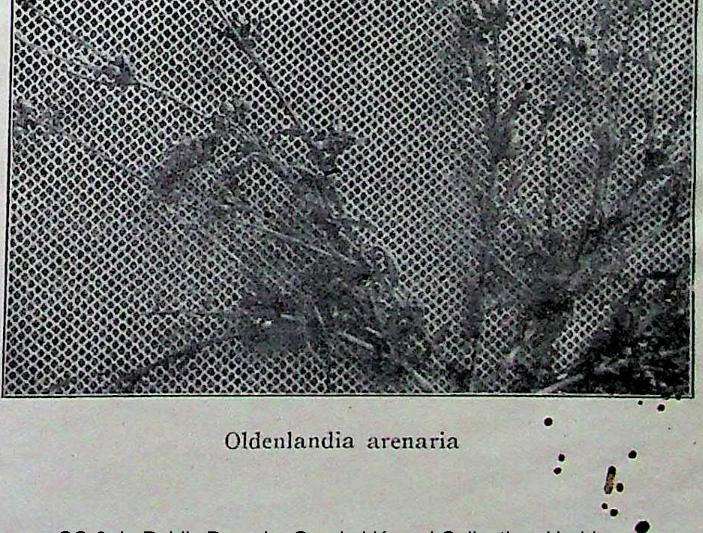
Thesium unicaule



Hypericum Gaitii



Ligusticum alboalatum



Oldenlandia arenaria

20. Note on Nitrogen. A New Method of Preparation.

By THE LATE HASHMAT RAI.

In the course of his work on "Electrolysis of Ammonium Chloride in Aqueous Solution" the author was led to the above investigation.

Kolbe (Journ. pr. Ch. 41, 137, 1847; Memoirs Ch. Soc. III, 285, 1848) observed that on passing an electric current through a concentrated solution of chloride of ammonium, hydrogen was evolved at the negative pole but neither oxygen nor chlorine at the positive pole. There is, however, nothing definite on record to show that nitrogen is evolved at the anode. Moreover no quantitative analysis of the anodic gas is to be found in the literature.

EXPERIMENTAL.

Fig. 1 gives a diagrammatic sketch of the apparatus employed. The electrodes are of smooth platinum foil. The diaphragm is made of a porous earthenware disc, cemented to the bottom of the cathode chamber by means of Goldschmidt cement. The electrolyte consists of a strong solution of ammonium chloride. Both the anode and the cathode chambers and the delivery tubes are completely filled with the electrolyte before the current is allowed to pass through it.

After the complete saturation of the liquid with the gas, the anodic gas is collected over water. A sample was analysed for oxygen by Hempel's apparatus, using thin and freshly prepared phosphorus sticks. It was estimated that the amount of oxygen contained in the anodic gas was less than 0·2 per cent. The gas was tested for chlorine which was found to be absent. This shows that the amount of nitrogen in the anodic gas is more than 99·8 per cent.

The small percentage, *i.e.* 0·2 per cent, of oxygen in the anodic gas may be attributed to the interaction of chlorine, formed at the anode, and water :—

$$2Cl_2 + 2H_2O = 4HCl + O_2.$$

Thus it appears that, for the preparation of still purer nitrogen, the anodic gas may be collected over caustic soda solution which would absorb chlorine and consequently obviate the formation of any oxygen.

Primarily chlorine is evolved at the anode which acts on ammonium chloride :—

$$NH_4Cl + 3Cl_2 = NCl_3 + 4HCl.$$

Nitrogen chloride is formed which again being unstable decomposes into its elements, *viz.* nitrogen and chlorine. This explains the production of nitrogen in the anode chamber.

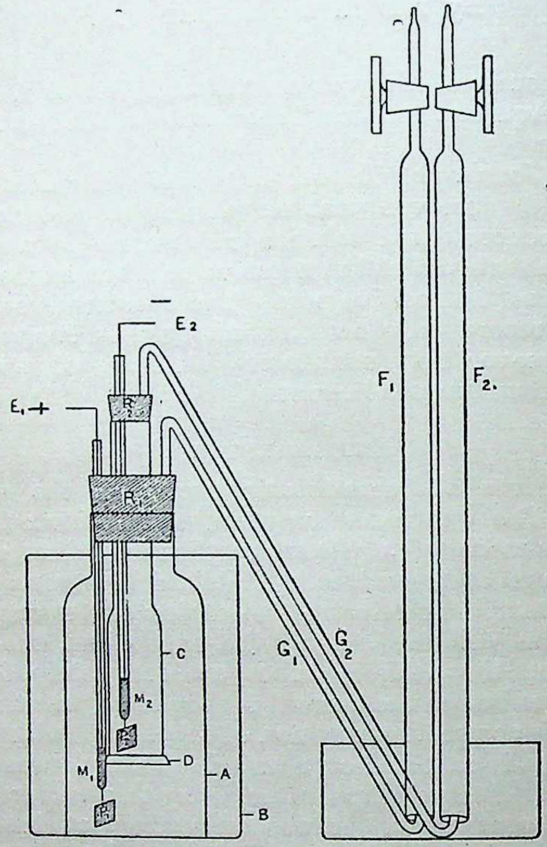


FIG. I

The above affords a new method for the preparation of a continuous supply of very pure nitrogen.

It must be noted that this method involves the formation of nitrogen chloride, a highly explosive substance, which constitutes a great drawback of the method.

The author desires to express his thanks to Professor Donnan for his advice and assistance.

21. The Purification of Indian Sesame (Til) Oil.

By THE LATE HASHMAT RAI AND H. B. DUNNICLIFF.

INTRODUCTION.

'Til' oil is used as an adulterant for 'ghee' and in many cooking operations is used alone, especially in Burma, as a 'ghee' substitute. It is used for making soap, anointing the body and for burning in lamps. It finds application in the process of dyeing silk, in painting, and in brightening tinctorial results. It is also used for medicinal purposes and as a substitute for olive oil. It is extensively employed in the manufacture of Indian perfumes. It is occasionally used as a lubricant. In Germany, Austria and Belgium it has, for some time, been a compulsory constituent of margarine.

Constituents of 'Til' Oil.—'Til' (Sesame) oil consists of the glycerides of stearic, palmitic, oleic, and linolic acids; 78% of the acids being liquid. It also contains special substances as 'sesamol,' 'sesamin,' etc. It is slightly optically active (d-rotatory ·8° to 2·4°).

The objects of the experiments undertaken were :—

(1) to attempt to bleach the oil by methods capable of commercial application,
(2) to deodorise the oil,
(3) to harden the oil.

A study of the available literature on the subject gives no special method which has been applied to the bleaching of this oil.

Work has been done on the hydrogenisation of the oil showing that sesame oil, by reduction with hydrogen in presence of a catalyst, can be converted into a hard tallow-like substance of any desired iodine value according to the treatment. The successful method was an application of that due to Sabatier and Senderens using finely divided nickel as a catalyst (Lewkowitsch).

EXPERIMENTAL.

Before the investigation of this problem was suggested to us by the Chemical Adviser to the Indian Munitions Board, Hashmat Rai had commenced a research on the subject independently and the experiments described under "Til Oil A" were conducted by him. The samples prepared in this way were examined after some four months. The value of this time factor will be easily noticeable from the results given in the Table I. The sample described under "Til Oil A, No. 3," is really an excellent one. Exposure to the air for some months has also had a marked effect on the results. This was to be expected from a semi-drying oil.

TABLE I.

The oil was mixed with excess of the material named in column No. II and heated in a basin with stirring for from 15 to 20 minutes at a temperature well below the decomposition temperature of the oil. The basin was removed from the flame and allowed to settle in the case of Til Oil A (unless otherwise stated) for three and a half months exposed to the air in contact with the substance in a dark cup-board, and in the case of 'Til oil B' allowed to settle for twenty hours, filtered and put into closed vessels.

I	II	III	IV
		TIL OIL A	TIL OIL B
No.	Substance with which the oil was treated.	All samples except 2 (*a*) and 6 (*a*) were left in contact with the substance mentioned in col. II for 3½ to 4 months exposed to the air and then filtered and bottled.	Samples were filtered and bottled at once.
1	Filtered ..	Control sample.	Control sample.
2	Powdered bazar charcoal.	(*a*) Filtered at once. Marked improvement in colour. (*b*) Filtered after about 4 months. Colour as in (*a*). Smell improved.	No improvement in colour or smell.
3	Animal charcoal.	Source unknown. An excellent sample, nearly white. Smell much improved and not unpleasant.	Hopkins & Williams. Marked diminution in colour. Second best sample in this set.
4	Fuller's earth, crude lumps.	No improvement in colour, taste or smell.	No improvement.
5	Fuller's earth, precipitated.	Not tried.	A marked improvement in colour. The best sample of this set.

I	II	III	IV
		TIL OIL A	TIL OIL B
No.	Substance with which the oil was treated.	All samples except 2 (*a*) and 6 (*a*) were left in contact with the substance mentioned in col. II for 3½ to 4 months exposed to the air and then filtered and bottled.	Samples were filtered and bottled at once.
6	'Multani mutti.'	(*a*) Filtered at once, oil appeared to become fluorescent, darker and very viscous. Smell improved. (*b*) Filtered after 4 months' exposure. Very viscous, darker and apparently fluorescent. Appears somewhat like vaseline. Smell negligible. The sample used in this test was somewhat smaller than those used in the others and the exposed layer was relatively thinner.	No improvement apparent.
7	French Chalk..	Very marked improvement both in colour and smell. Taste improved.	Very slight bleaching effect.
8	Kharya mutti.	Not tried.	Moderate improvement, in colour.
9 & 10	Quicklime ..	Not tried.	No improvement, cold or heated.
11	Air driven through for 6 hours at 80°C.	Very small change in colour. Marked improvement in smell.	Not tried.

'Multani mutti' and 'kharya mutti' are varieties of naturally occurring Indian clay, most commonly met with in the Indian market.

EFFECT OF SUNLIGHT.

In order to ascertain the effect on the oil, of sunlight in absence of air, six test-tubes full of filtered 'Til' Oil B and closed with ordinary corks were kept exposed to sunlight in the direction of East and West on the roof to secure the maximum effect of sunlight. After intervals of a week each one test tube was removed, stored in the dark, and compared with the original control sample of 'Til' Oil B

It was found that, in absence of air, exposure to sunlight reduced the smell somewhat. There was an improvement in colour which was more marked after the second week. There was a slight further bleaching observed up to the sixth week.

EFFECT OF AIR AND SUNLIGHT COMBINED.

A series of experiments was conducted to study the combined effect of both air and sunlight on the oil.

Fig. 1 gives the diagrammatic sketch of the apparatus employed.

A. Dropping funnel.
B. 'Til' oil.

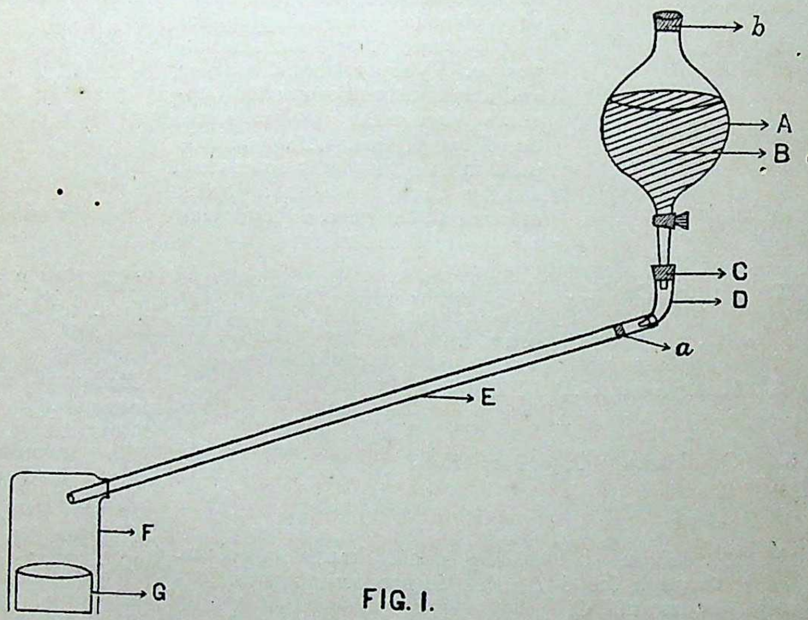


FIG. I.

C. Cork.
D. Adapter.
E. Glass tube about six feet long and of $\frac{5}{8}$ inch internal diameter.
F. Glass shade.
G. Glass basin.
a. Cotton-wool plug to stop the formation of spheroidal oil-globules.
b. Cotton-wool plug to keep off dust particles without obstructing the inflow of air.

The oil was contained in the dropping funnel A and by adjusting the stop-cock was allowed to glide slowly along the slanting glass tube E, held in position by means of a clamp. The treated oil was collected in the glass receiver, G, and poured back into the funnel A. The oil was, on the average, run about twice a day. The samples were taken after suitable intervals and compared with the control sample. It was found that, in dripping from the dropping funnel, the drops frequently assumed the form of spheres which rolled down the slanting tube and shot beyond the end on to the walls of the covering glass. This was prevented by the insertion of the plug of cotton-wool (*a*).

Exposure to both air and sunlight gave a progressive improvement in colour.

In the first sample of oil, after nineteen days' treatment, the oil was practically white and the smell, though not absent, was not unpleasant.

In the second sample, treatment in the same way showed moderate improvement in colour after fourteen days. The smell was still unpleasantly apparent, though a marked improvement on the original sample. After 21 days' treatment the colour further improved but the smell was about the same as after 14 days. Twenty-eight days' exposure resulted in a marked improvement in colour over the sample treated for twenty-one days.

After twelve weeks' treatment the sample resembled pure glycerine both in colour and consistency. It was practically colourless. The odour, however, still remained unchanged.

EFFECT OF SULPHURIC ACID.

'Til Oil' was treated with a varying amount of strong sulphuric acid at room temperature with constant shaking for a limited period, subsequently washed with water and allowed to settle over-night in each case, followed by syphoning off the acidic water. This process of washing was repeated several times till the oil was free from acid.

A series of 21 experiments was conducted in four sets.

The first set comprised three experiments 100 c.c of the oil was treated with 1 c.c., 2 c.c., and 3 c.c. of strong sulphuric acid respectively and the period of acid contact before washing with water was 19 hours. The sample number 1, i.e. treated with 1 c.c. of acid, showed improvement in colour which was practically of the same degree as in sample No. 9. Samples Nos. 2 and 3 were darker.

In the second set comprising six experiments 100 c.c. of the oil was treated with 1 c.c. of acid and the period of acid-contact varied from 5 to 30 minutes with an interval of 5 minutes each. Samples Nos. 4 to 8 showed no improvement in colour but in sample No. 9 the colour was improved to the same degree as in No. 1 of the first set.

The third set comprised six experiments. 100 c.c. of the oil was treated with 2 c.c. of acid and the period of acid-contact varied in regular intervals from 5 to 30 minutes.

Samples Nos. 10 to 13 showed slight improvement in colour while in samples Nos 14 to 15, there was slightly increased improvement

In the fourth set, comprising six experiments, 50 c.c. of the oil was treated with 1·5 c.c. of the acid and the period of contact varied in regular intervals from 5 to 30 minutes. No change in colour was observable in any of the samples.

The control sample appeared slightly greenish. In all the sulphuric acid experiments the greenish tinge was reduced.

From the above results it is clear that low acid-contents and long acid-contact (vide samples Nos. 1 and 9) are factors which are helpful in the bleaching of the oil by the acid-process.

As regards odour, it practically disappeared in all the samples. On warming the treated samples the odour comes back and resembles that of the control sample. On cooling, however, the odour again disappears.

EFFECT OF CAUSTIC SODA.

'Til' oil was treated at room temperature with different amounts of caustic soda and for varying periods of alkali-contact, with constant shaking. It was then washed with water and the mixture was left overnight undisturbed in each case. The alkaline water was syphoned off. The process of washing the oil with water was repeated several times till the oil was free from alkali, phenolphthalein being used as an indicator.

A series of 34 experiments was conducted in five sets. The strength of the caustic soda solution used was 94·8 grms. per litre. 100 c.c. of the oil was taken for each experiment.

The first three sets comprised six experiments each. The oil was treated with 10 c.c., 20 c.c, and 30 c.c. of the standard alkali solution respectively. The period of alkali-contact before washing with water varied from 5 to 30 minutes with intervals of 5 minutes each.

In the whole series of 18 experiments the odour was practically entirely removed. In every case the colour was much improved. So far as colour and odour were concerned, there seemed to be no advantage of the higher alkali-contents, i.e. 1·896 grms. and 2·844 grms. per 100 c.c. of the oil over the lower one, i.e. 0·948 grm. per 100 c.c. of the oil. Changes both in colour and odour were independent of the period of the alkali-contact.

In the fourth set comprising six experiments the oil was treated with 1 c.c. of the alkali solution (i.e. containing 0·0943 grm. of caustic soda). The period of alkali-contact varied from 5 to 30 minutes with intervals of 5 minutes each. The colour, though an improvement over that of the control sample and better than that of the acid-treated samples, did not show any marked degree of improvement.

The fifth set comprised ten experiments. The oil was treated with different quantities of the alkali solution varying from 1 c.c. to 10 c.c. with a constant difference of 1 c.c. The period of the alkali-contact, before washing with water, was one hour in every case.

In samples Nos. 25, 26, and 27, containing 1 c.c., 2 c.c., and 3 c.c. of the alkali solution respectively, a slight progressive improvement both in colour and odour was observed. Sample No. 28, containing 4 c.c. of the alkali solution, showed a marked improvement. Samples Nos 29 to 34, though containing different and increasing amounts of alkali, exhibited exactly the same degree of improvement both in colour and odour. Thus sample No. 28, containing 0·3792 grm. of caustic soda per 100 c.c. of the oil, marked a critical point in the improvement of the oil. Further, it is obvious that the minimum quantity of caustic soda required for the purification of the oil is 0·4740 grm. per 100 c.c. of the oil.

A couple of experiments were performed with 1,000 c.c. of the commercial oil which was treated with an alkali solution containing 0·5 gram of caustic soda. The oil showed an excellent improvement both in colour and odour.

It may be noted that the above results hold good in the case of the variety of the oil used for the experiments, and will have to be modified slightly when applied to the commercial sesame oil which is to be met with in several grades on the market

On warming the treated samples the odour is perceptible and not unpleasant but of a nature quite different from that of the control sample. On cooling, however, the odour disappears.

When a mixture of 'ghee' (the so-called clarified butter in India) and the treated oil is warmed, its odour resembles that of rancid 'ghee.' It is most likely that the odour of the oil is masked by that of the 'ghee.' On cooling the odour of the oil is not perceptible. The same remarks apply to the oil treated with sulphuric acid.

SUMMARY AND CONCLUSION.

The results of the investigation may be summarised as follows :—

(1) Of all the filtering materials, used for the purification of the oil, bone charcoal and French chalk (precipi-

tated) are the best decolorising agents. All of them are ineffective as deodorising substances.

(2) Exposure to sunlight alone gives progressive improvement in colour but the odour remains practically unchanged.
(3) Treatment with air alone has a progressive decolorising effect, but the odour still persists.
(4) Exposure to both air and sunlight combined has a very marked effect on the colour of the oil. The smell, though not absent, is not unpleasant.
(5) Treatment with sulphuric acid reduces the colour slightly, but the odour disappears in all the samples.
(6) Caustic soda acts both as a very good decolorising and deodorising agent. The minimum quantity of caustic soda required for the purification of the oil is 0·4740 gram per 100 c.c. of the oil.
(7) In all the samples, bleached by different methods, the colour more or less comes back on standing for a long period.
(8) On warming all the samples, deodorised by different methods, the odour is perceptible. On cooling, however, it disappears.

The experimental work was done by Hashmat Rai.

Chemical Laboratory,
Government College, Lahore, India.

22. A Letter from the Emperor Bābur to his son Kāmrān.

By H. Beveridge, I.C.S. (retired).

The world owes its knowlege of this letter to Julius von Klaproth, the oriental scholar and pioneer of Chaghatai studies. He published it in the original Turkī in his Memoires Relatifs a l'Asie, Vol. II, pp. 148-151, Paris, 1826. Previously to this he had published at St Petersburg in 1810 in his Archiv for Asiatic Literature, Vol. I (all that ever appeared), an article on Bābur's Memoirs, and had given there a translation of Bābur's description of Ferghāna. Another German scholar, Dr. George Jacob Kehr, saw the letter to Kāmrān, nearly a hundred years before Klaproth did: see the R.A.S.J. for 1909, p 454. Kehr, apparently, was the first European scholar who studied Bābur's Memoirs, and the work he did upon them was most important. Mrs. Beveridge has given some account of him in an article in the R.A.S.J. for 1900, p. 467. He was born in 1692, and in 1731 he became Professor of Oriental languages at St. Petersburg. In 1737 he made a complete copy of a Turkī MS of the Memoirs, and as his original has disappeared, this copy is the only source of Ilminsky's edition of 1857, and of the French translation by Pavet de Courteille. Two years later (1739), Kehr made a Latin translation of the Memoirs as far as 908 A.H. (1502-03). Presumably this is now in St. Petersburg. (R.A.S.J. for 1908, p. 828). It is bound up in two volumes, and apparently, in Kehr's time it contained some detached documents which either no longer existed when Klaproth examined the volumes, or which he overlooked. At least he has only noticed the letter to Kāmrān, and does not mention the curious passage in which Bābur refers to Kāmrān's mother-in-law (see R A S.J., p. 830). Perhaps, however, this is because the passage only exists in Kehr's Latin translation. Both Kehr and Klaproth give the note describing how the Bāburnāma came into the possession of an unknown owner in 957 A.H. (May 1550).

Of the two articles of Klaproth's dealing with the Bāburnāma, the second, that is the article of 1826, is much the most interesting, as it contains Bābur's letter to Kāmrān, in original and in a French translation and also gives valuable information about the Bokhara MS. which seems to be the oldest existing MS. of the Bābur-Memoirs. A Turkī note at p. 135 of Klaproth's article shows that the Bokhara MS. was at least as old as May 1550, i.e. only about twenty years after Bābur's death, for on that date it was given to an unnamed traveller of rank, in Simau Tau at a road-station called Ḥājī Tāsh. This note is also given by Kehr, in a Latin translation, and it is curious that neither he nor Klaproth explains the enigmatical words Simaû Taû. There is a place called Simau Tau in Asia Minor which possibly may be the place where the gift was made. See infra. There is also a Ḥājī Tāsh marked on the maps of Badakhshān. The note cannot, I think, be by Humāyūn. The bad spelling of the word Ḥājī is against this and also against the notion that Kāmrān was the writer. It seems probable that the donee was on his way to Bukhara and that he carried the MS. there, for another Turkī note shows that it was bought at Bokhara many years afterwards by a member of the suite of Florio of Beneventum (?) who was the ambassador of Peter the Great about 1721.

I now proceed to give translations of the note of the Russian Muhammadan who acquired the Bokhara MS. and of Bābur's letter to his son Kāmrān.

TRANSLATION OF THE TURKĪ NOTE OF TĪMUR PŪLĀD IN THE BOKHARA MS.

"This book of the Bāburnāma was purchased by me Timur Pūlād (Pūlāt in text, it means steel) s. Mīrzā Rajab s. Paichīn when I came to Bokhara in company with Florio Beg Banīvīn (Beneventum ?), the Russian ambassador of the great king (the Czar), who is the crown of the Sun and the ruler of soldiers brave as leopards, and numerous as the stars. May the purchase be fortunate!"

Note.

Klaproth gives 1718 as the date of the dispatch of the embassy, but it appears from Schuyler's book on Turkistan that the period of the embassy was 1721-25. Peter the Great died on 28th January, 1725, and apparently Florio did not return to Russia till after the emperor's death. From Klaproth's note in the article of 1810 it appears that the Turkī note of 957 A.H. is at the end of the Bāburnāma MS. The letter to Kāmrān says nothing about the dispatch of the Bāburnāma. It may have gone separately and later. Nor does the letter say anything about the poisoning of Bābur, or about the sending of Ibrāhīm's child. The attempt to poison Bābur took place in December 1526, eight or nine months after the battle of Pānīpat. Ibrahim's son and mother were sent to Kāmrān in January 1527. The Fatḥnāma spoken of in the letter is not the one drawn up by Shaikh Ẓain for the victory over Rānā Sangā. It is an earlier one written shortly after the battle of Pānīpat, and which we have not got, there being no copy of it in the Memoirs. It follows, I think, that the letter to Kāmrān was written in 932 A.H. and probably in April or May

1526. Kāmrān was set to work by his father on the cave of Qandahar in 928 A.H., and I think he stayed there several years. But Bābur's letter shows that Kāmrān was not always there. He had just returned to Qandahar from some expedition when Bābur wrote to him. It may have been on one of these expeditions that he was defeated by the Rājputs, if their chronicles are correct. He was in Balkh, or was going there in 935 A.H. See Haid. MS., pp. 348 and 350, and the translation thereof, pp. 625-626. It was, perhaps, in 953 A.H. that he made over Qandahar to 'Askarī.

Apparently, the construction of the vault in cave, at Qandahar, occupied five years, namely, from 928 to 933 A.H.

Note.

As I have stated, only one volume of Klaproth's Archiv ever appeared. His article No. IV is interesting as being the first attempt to introduce Bābur's Memoirs to European scholars. There is a copy of the Archiv in our Society's Library, it having been presented in 1815 by the Emperor of Russia, and there is a copy in the British Museum. The honour of being the first person to publish an extract from the Memoirs in the original Turkī or Chaghatai is due to an Englishman, viz. the brilliant Jewish scholar Arthur Lumley Davids. He was born in Hampshire in 1811, and died of cholera in 1832. A few weeks before his death, he published a Turkish Grammar accompanied with extracts in Turkish and Chaghatai, and among the latter was Bābur's description of the city of Samarkand which occurs under the year 903 (1497-98) of his Memoirs. Four years after her son's death, his mother published a French translation of his work, and this is the only edition that I have seen. The extract occurs at p. 188 and is taken from an MS. then belonging to the East India Company but which had originally belonged to the poet Leyden, and so is catalogued as part of the Bibliotheca Leydeniana. It is not known how Leyden obtained it, but probably it is a copy of the Tippu Sultan or Mysore Bāburnāma which is now in the Asiatic Society of Bengal's Library. Neither the A.S.B. copy nor Leyden's has anything to do with the Elphinstone copy of the Memoirs which there is good reason to believe that Leyden never saw. Elphinstone thought he had lent his copy to Leyden and that it had gone to Java, but apparently it had never left his own shelves at Poonah.

TRANSLATION, FROM THE TURKĪ, OF THE HORTATORY LETTER SENT FROM INDIA BY KING BĀBUR THE GHĀZĪ, R.I.P., TO HIS SON MĪRZĀ KĀMRĀN AT QANDAHAR.

"My dear, honoured and auspicious son Mīrzā Kāmrān Bahādur. After sending you my love, I desire in the first place to express the peace of my soul and the delight of my heart at hearing that you yourself, your foster-brothers, your saddle-comrades, and your other intimates, have returned to your old studies.[1]

I record in this paper a hundred thanks to Almighty God for this favour. I trust that you will continue in your good way and that you will acquire abilities and graces and eventually attain to excellence. See that you fall not away from the good course, and that you bear in mind the words of his holiness Khwāja Ḥāfiẓ. "Old men speak from experience." "Yes, I say unto you, my child, give ear to the instructions of the aged."

I hear that those Chaghatais who stayed in Herat after the death of Sulṭān Ḥusain Mīrzā, R.I.P., became yet more allied with the people of Khūrāsān, and so became alienated (*qūpūb-*; from their old ways in Transoxiana). They developed much ability, and acquired graces, (but) though the Khurāsānīs are a pleasant folk, and there can be no question about their cleverness, there is doubt about their religion, and their principles, and they are a nation of make-bates and agitators. The sons are alienated from the fathers, and the fathers from the sons. Do not be deceived by their plausible ways, and for your own safety's sake, do not let them get out of hand.

Among the Turkish tribes there is a house which observes the Gūrgān customs (*torā gūrgān*) and in which the fathers have been for generations the chiefs[2] of actions, while the mothers have been the chiefs of domestic matters. They have served our family with life-long devotion. In heat and in cold, at home and abroad, they have not for a minute, or the twinkling of an eye, swerved from their duty, and have always done good service. Study this family, proceeding steadily along like a good roadster,[3] and select from it, after examination, your chief minister (*vakīl matlaq*). Do not neglect this. As for young men, do not let yourself act according to their words and don't put any affairs into their hands. Act according to the opinions of thoughtful Begs who are of lofty mind, and who honestly express their opinions (*qarāju*. See P. de C. Dict., p. 417 s.v. *qarājī*). Never neglect the sentiments of those who have been versed in business, and in deliberations, and discussions! Be not misled by flatterers and plausible people. Should they chance to say anything to the purpose, hear it, see it and perpend it. It may, however, happen that what at first looks sound turns out to be a quite old drum and so a thing to furnish sorrow to friends and laughter to foes. (Perhaps there is an allusion to the story of the Fox and the Drum Anwārī Sohailī, Eastwick's translation, Story VII of Chap. I.)

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[1] *sabaq aqūrgha.* I am not sure of the meaning.

[2] *qūl bāshlāghan.* See P. de Courtelle's Dict., pp. 150, 151 s.v. bāshlāmāq. The word bāshlāgān occurs again, p. 150 of Klaproth's article nine lines from foot. Can the family have been that to which Bairam Khān belonged, and be descended from the 5 or 6,000 Turkamans who entered the service of Bābur's grandfather? Can the two women who accompanied Bābur's flight from Samarkand in 1502 (Haid, f. 95) have belonged to it?

[3] *ishkinkā*, the *ishkin* of P. de C. Dict. 115. Perhaps the whole phrase is "putting him (the prospective candidate) on his trial as if he were a horse, and you wanted to see if he ambled well." See also Zenker, p. 55.

Discriminate (*tānīb*, having recognised) between friends and foes. As the verse has it, "In the flowerbed, a flower, in the thornbrake, a thorn."

As regards (*tāqī*, again, item) the Qandahar army, it is a militia (*ihshām*). Do not accept a recruit on the recommendation of an ordinary[1] person of no particular importance, but in case of necessity appoint any one that you think fit. Observe the procedure of the leaders of assemblies, follow the rules and ceremonies of the Gūrgāns (*tora tawaqa gūrgān tuzūk*; see P. de C. Dict. 240, s.v. *tawaqa* and Haid MS., 237^b); be hearty and frank with your well-wishers, and speak politely to people in general. Set out on an expedition after full preparation. Listen to everybody, and get acquainted with everybody whether they are far off or near at hand. As for insignificant and meanly-born people, do not educate them or employ them in state-affairs, even though they be well-dispositioned and possessed of ability. As his Excellency Shaikh S'aādī has said: "A nobody does not become somebody by being educated. Tulips grow in gardens, weeds and thorns in saline soil." Ḥaẓrat Maulānā Jāmī's verse is well known: "A really worthless person does not become efficient by change of circumstances. Transpose the words *sag magas* (dog fly) the heart (of the beast) still remains sag-magas.

The people of Transoxiana are simple, but when they have brains they are worthy of trust and of office. By the incitement of that orb of the night, that candle of light and majesty, that eloquent nightingale of the flower garden—Ḥaẓrat Khwāja Ubaid Ullāh, who has rendered help, through them (the people of Transoxiana) you have become a disciple and a companion, and been called the son of a Pādshāh. See that you do them due honour and that you make no short-coming in this. (For) "They who dwell within the portals of Love love even the name of the Beloved.

As for the affairs of India, you will learn them from the Bulletin of Victory. The son of Ibrāhīm who was the king of

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[1] Naturally, Klaproth did not know the technical word *ihshām*, nor the Chaghatai expression *kīchīkkarīm*. See Irvine's Army of the Indian Moghuls, p. 160, for the first word, and P. de C.'s Dict. 458 for *kīchīkkarīm*. See also Haid. MS., pp. 270 and $294\text{-}95^b$. P. de C.'s Dict. is earlier than his translation of the passage in Ilminsky where the words occur, but I do not think the translation in the latter an improvement.

India, has fallen into our hands. I have sent (the Bulletin) to you, my dear son, in order that you may become acquainted with its contents. Hereafter whatever occurs will be reported to you. Goodbye.

NOTE.

It seems strange that Bābur should be so emphatic on warning his son against the Khurāsānīs, for the boy was at Qandahar and not likely to have many dealings with Persia or the Persians. Perhaps, the explanation is that Bābur is replying to some enthusiastic expressions of Kāmrān about the Persians in a letter to which Bābur's is a reply. Bābur's letter is interesting on account of its domestic and affectionate character, and of its numerous quotations. It is a more natural and more pleasing letter than the somewhat pedantic and fault-finding one to Humāyūn.[1] It is in some places a difficult one, and I am not sure if I have always caught the meaning. Klaproth's French translation is a very good one to have been made in the early days of Chaghatai studies, and by a man who had not access to a Turkī dictionary. It has been very useful to myself. Klaproth states that in the MS. he saw in St. Petersburgh, Bābur's letter preceded the Memoirs. At p. 135 of his article he gives the note dated 1550 which mentions the acquisition of the MS. by a former owner.

As for the station Ḥājī Tāsh which is mentioned in the note of 957 A.H. I am inclined to think that Ḥājī Tāsh may mean Ḥājī Bek Tāsh the legendary founder of the Janissaries (see Ency. of Islam, No. XI, p. 691) and that the station was somewhere in Asia Minor and in what may be called the Bektāsh country. There is a Simau Tau or mountain range, and there is a Simau (it seems to be both a village and a range of mountains) marked on Keith Johnston's map of Turkey in Asia. It is almost due south of Constantinople and Brusa, and on a line with Mitylene. It is S.W. Kutaya. There is a *takkaya* or shrine at Eski shahr. The unnamed traveller may have been on his way from Constantinople or Smyrna.

Lest the existence of an interesting vocabulary should be overlooked, I desire to notice here that the third volume of Klaproth's Memoires Relatifs contains at pp. 113-256 a curious list of words in Latin, Persian and Coman. They come from a MS. left by the poet Petrarch to the Republic of Venice in 1303. The Comans are a nation or tribe inhabiting the northern shores of the Black Sea, and their language is allied to Turkish.

H. BEVERIDGE.

26th July, 1919.

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[1] **Bābur's Memoirs, Leyden and Erskine's translation, p. 390.**

JULY, 1919.

The Monthly General Meeting of the Society was held on Wednesday, the 2nd July, 1919, at 9-15 P.M.

MAHAMAHOPADHYAYA HARAPRASAD SHASTRI, C.I.E., M.A., F.A.S.B., President, in the chair.

The following members were present :—

Maulavi Abdul Wali, Dr. N. Annandale, Dr. P. J. Brühl, Dr. L. L. Fermor, Mr. G. H. Graves, Mr. J. Insch, Mr. H. W. B. Moreno, Dr. Satis Chandra Vidyabhusana.

Visitor :—Mrs. Insch.

The minutes of the last meeting were read and confirmed.

Twenty-three presentations were announced.

The President announced that Dr. F. H. Gravely had been appointed Biological Secretary of the Society in the place of Mr. S. W. Kemp resigned, and that Major C. L. Peart had been appointed a member of Council.

The General Secretary reported that Lieut.-Col. Sir S. G. Burrard, K.C.S.I., and Babu Kedar Nath Dutt, ordinary members, had expressed a desire to withdraw from the Society.

The following gentlemen were balloted for as ordinary members :—

Babu Pramatha Nath Banerjee, M.A., D.Sc., Lecturer, Calcutta University, proposed by the Hon. Justice Sir Asutosh Mookerjee, seconded by the Hon. Dr. A. Suhrawardy; *Babu Pramatha Nath Banerjee*, M.A., B.L., Vakil, High Court, 116B, Harish Mukerji's Road, Calcutta, proposed by the Hon. Dr. A. Suhrawardy, seconded by Dr. Satis Chandra Vidyabhusana; *The Hon'ble Nawabzadah Amin-ul-Islam, Khan Bahadur*, B.L., Inspector-General of Registration, Bengal, proposed by the Hon. Justice Sir Asutosh Mookerjee, seconded by the Hon. Dr. A. Suhrawardy; *Mr. Z. Zafar Hasan*, Assistant Superintendent, Archæological Survey of India, Delhi, proposed by Mr. R. D. Banerji, seconded by Dr. Satis Chandra Vidyabhusana.

The following gentleman was proposed as an associate member :—

H. Bruce Hannah, Esq., Bengal Club, Calcutta.

The following papers were read :—

1. *Hindu Astronomical Deities.—By* G. R. KAYE.

2. *Note on Ancient Romic Chronology.—By* H. B. HANNAH. *Communicated by* SIR ASUTOSH MOOKERJEE.

The reading of the following papers was postponed :—

1. *Interaction of Phosphorus Halides and arsenious and arsenic Compounds.—By* NAGENDRA NATH SEN. *Communicated by the Physical Science Secretary.*

2. *Notes on the Panchet Reptile.—By* HEM CHANDRA DAS-GUPTA.

3. *Note on a Mammalian Fossil from Bhavanagar (Kathiawar).—By* HEM CHANDRA DAS-GUPTA.

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SEPTEMBER, 1919.

The Monthly General Meeting of the Society was held on Wednesday, the 3rd September, 1919, at 9-15 P.M.

MAHAMAHOPADHYAYA HARAPRASAD SHASTRI, C.I.E., M.A., F.A.S.B., President, in the chair.

The following members were present :—

Maulavi Abdul Wali, Mr. S. N. Bal, Dr. P. J. Brühl, Babu Nilmani Chakravarti, Miss M. L. Cleghorn, Dr. H. H. Hayden, Babu Narendra Kumar Majumdar, Mr. Johan van Manen, Mr. R. D. Mehta, Mr. H. W. B. Moreno, Raja Bhupendra Narayan Sinha Bahadur of Nasipur, Babu Ganapati Sircar, Dr. Satis Chandra Vidyabhusana.

Visitors :—Mr. C. Cleghorn, Miss O. Cleghorn.

The minutes of the July meeting were read and confirmed.

Forty-five presentations were announced.

The General Secretary reported that Col. H. T. Pease, C.I.E., Miss R. Guha, Prof. E. J. Rapson, Mr. H. G. Tomkins, Sir John Woodroffe, Kt., and Mr. E. R. Watson, ordinary members, had expressed a desire to withdraw from the Society.

The General Secretary reported the death of Nawab Haji Mahomed Ishak Khan, an ordinary member of the Society.

The General Secretary also reported the death of M. Jean Gaston Darboux and Prof. John Wesley Judd, Honorary Fellows of the Society.

The following gentleman was balloted for as an associate member :—

H. Bruce Hannah, Esq.

The following gentlemen were balloted for as ordinary members :—

Babu Devi Prasad Saksena, Sub-Deputy Inspector of Schools, Farrukhabad, U.P., proposed by Babu Munna Lal, seconded by Lala Sita Ram; *Mr. Kastur Chand Vyas*, The Bikaner Trading Coy., 81, Clive Street, Calcutta, proposed by Mahamahopadhyaya Haraprasad Shastri, seconded by Babu Punchanon Mukhopadhyaya; *Mr. Mohammad Sanaulla*, M.Sc., F.C.S., Archæological Department, Indian Museum, Calcutta, proposed by Dr. B. L. Chaudhuri, seconded by Dr. Satis Chandra Vidyabhuṣana.

The following papers were read :—

1. *The Purification of Indian Sesame (Til) Oil.—By* HASHMAT RAI *and* H. B. DUNNICLIFF. *Communicated by* DR. J. L. SIMONSEN.

2. *Note on Nitrogen. A new method of Preparation.—By* HASHMAT RAI. *Communicated by* DR. J. L. SIMONSEN.

3. *On the Rationalisation of Algebraic Equations.—By* NRIPENDRA NATH CHATTERJEE. *Communicated by* SIR ASUTOSH MOOKERJEE.

4. *Radiation Pressure: the fallacy in Larmor's proof. By* E. G. BARTER.

5. *A Letter from the Emperor Bābur to his son Kāmrān.— By* H. BEVERIDGE.

All these papers have been or will be published in the *Journal.*

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NOVEMBER, 1919.

The Monthly General Meeting of the Society was held on Wednesday, the 5th November, 1919, at 9-15 P.M.

MAHAMAHOPADHYAYA HARAPRASAD SHASTRI, C.I.E., M.A., F.A.S.B., President, in the chair.

The following members were present :—

Dr. N. Annandale, Miss M. L. Cleghorn, Rev. Father E. Francotte, S.J., Mr. H. G. Graves, Mr. Johan van Manen, Mr. H. W. B. Moreno.

Visitors :—Mr. C. Cleghorn, Miss O. Cleghorn.

The minutes of the September meeting were read and confirmed.

Thirty-one presentations were announced.

The General Secretary reported that Lieut.-Col. J. Stephenson, I.M.S., had expressed a desire to withdraw from the Society.

The General Secretary also reported the death of Rai Bahadur Monmohan Chakravarti and Mr. James Crawfurd, ordinary members of the Society.

The President announced that Captain Sir George Duff-Sutherland-Dunbar, Bart., and Babu Mritunjoy Rai Chaudhury, being largely in arrears with their subscriptions, their names would be posted in accordance with Rule 38.

The President also announced that Mr. Johan van Manen had been appointed a member of the Library Committee.

The following three gentlemen were elected ordinary members during the recess in accordance with Rule 7 :—

The Hon. Mr. J. T. Marten. I.C.S.
Babu Ganesh Datta Vyasa, Kavyatirtha.
Babu Ram Bubu Saksena.

The following gentlemen were balloted for as ordinary members :—

F. A. Larmour Esq., Merchant, 60, Bentinck Street, Calcutta, proposed by Lieut.-Col. D. McCay, I.M.S., seconded by Dr. W. A. K. Christie ; *E. H. Pascoe Esq.*, Superintendent, Geological Survey of India, Calcutta, proposed by Mr. A. H. Harley, seconded by Dr. W. A. K. Christie ; *J. S. Gambhir, Esq.*, Professor of Persian, Samaldes College, Bhavnagar (Kathiawar), proposed by Dr. W. A. K. Christie, seconded by the Hon. Dr. A. Suhrawardy ; *Raj Guru Hemraj*, Raj Guru to the Maharajadhiraj of Nepal, Dhakatal, Nepal, proposed by Mahamahopadhyaya Haraprasad Shastri, seconded by Dr. W. A. K. Christie ; *Babu Shyam Narayan Singh*, B.A., Personal Assistant to the Commissioner of Muzaffarpore, proposed by the Hon. Justice Sir Asutosh Mookerjee, seconded by Babu Girindra Nath Mookerjee ; *Babu Baboolal Mayashanker Dube*, Head Master, Crawford High School, Kanker, C.P., proposed by Rai Bahadur Hiralal, seconded by Dr. W. A. K. Christie ; *Babu Pramatha Nath Misra*, Pleader, Malda Judge's Court, Malda, proposed by Dr. B. L. Chaudhuri, seconded by Dr. Satis Chandra Vidyabhusana.

Mr. Johan van Manen exhibited a collection of Lepcha manuscripts.

The General Secretary, on behalf of Mr. K. A. K. Hallowes, exhibited some neolithic stone axes from the Pakokku District, Upper Burma, and read the following note on them :—

During a visit to the Pakokku District, Upper Burma, in

December, 1918, I observed a large number of neolithic stone-axes and other objects of interest between Kyauksauk and Taungya, in the Myaing Township, at a point situated 1830 feet due north of the latter village.

At this locality, along a length of one furlong in a direction running N. 65° W., were obtained the following objects lying loose on the surface of the soil, which here thinly covers the Irrawaddi Sandstone series, and forms cultivated fields:—(1) highly polished neolithic stone-axes, which the microscope shows to be composed of siliceous schist containing a little chloritized sericite; the material of which these are formed must have been brought from afar, from some such area of crystalline rocks as that existing west of Yesagyo, in the Pakokku District, or E. of Yamethin; a corroded fragment of a copper vessel was discovered along with them, (2) teeth and bones, which my colleague Dr. Pilgrim, who has kindly examined them, finds to be the remains of oxen of quite recent times, since they exhibit only a small degree of fossilization, (3) a small long cylindrical stone, with a hole at one end, which may have been some sort of neck ornament, and finally, (4) wrist-bangles of somewhat crude design, made of polished serpentine.

The Thugyi, or head-man of Kyauksauk, informed me that the locality was, in early times, the site of an ancient Chin village. It is probable, therefore, that the teeth and bones are the remains of oxen owned by these Chin villagers, and that the stone-axes, which are Neolithic and post-Pleistocene, belonged to their prehistoric fore-fathers, who, also, ages ago, possibly occupied the same site.

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DECEMBER, 1919.

The Monthly General Meeting of the Society was held on Wednesday, the 3rd December, 1919, at 9-15 P.M.

MAHAMAHOPADHYAYA HARAPRASAD SHASTRI, C.I.E., M.A., F.A.S.B., President, in the chair.

The following members were present:—

Mr. W. E. Andrews, Dr. N. Annandale, Miss M. L. Cleghorn, Rev. Father E. Francotte, S.J., Mr. H. B. Hannah, Mr. H. W. B. Moreno, Dr. Satis Chandra Vidyabhusana.

Visitors:—Mr. C. Cleghorn, Miss O. Cleghorn.

The minutes of the last meeting were read and confirmed.

Thirty presentations were announced.

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The General Secretary reported that Babu Charu Deb Banerjee had expressed a desire to withdraw from the Society.

The General Secretary also reported the death of Dr. Amrita Lal Sircar and Mr. V. Subramania Iyer, M.A., F.L.S., F.Z.S., ordinary members, and Lord Rayleigh, an Honorary Fellow of the Society.

The following gentleman was balloted for as an ordinary member:—

N. C. Sen, Esq., Bar-at-law, Judge, Small Cause Court, proposed by the Hon. Dr. A. Suhrawardy and seconded by the Hon. Justice Sir Asutosh Mookerjee.

The following papers were read:—

A Loom used by the Gaodar Herdsmen of Seistan.—By N. ANNANDALE.

The Utility of desiccants in Electrostatic measurements.—By V. H. JACKSON *and* A. T. MUKERJEE.

Improvements in measurements with Quadrant Electrometers, Part II. Simplified arrangements for accurate and continuous work.—By V. H. JACKSON *and* A. T. MUKERJEE.

These three papers will be published in the *Journal*.

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PRINCIPAL PUBLICATIONS OF THE SOCIETY.

Asiatic Researches, Vols. I—XX and Index, 1788—1839.
Proceedings, 1865—1904 (now amalgamated with Journal).
Memoirs, Vol. 1, *etc.*, 1905, *etc.*
Journal, Vols. 1—73, 1832—1904.
Journal and Proceedings [*N. S.*], Vol. 1, *etc.*, 1905, *etc.*
Centenary Review, 1784—1883.
Bibliotheca Indica, 1848, *etc.*

A complete list of publications sold by the Society can be obtained by application to the Honorary Secretary, 1, Park Street, Calcutta.

PRIVILEGES OF ORDINARY MEMBERS.

(*a*) To be present and vote at all General Meetings, which are held on the first Wednesday in each month except in September and October.

(*b*) To propose and second candidates for Ordinary Membership.

(*c*) To introduce visitors at the Ordinary General Meetings and to the grounds and public rooms of the Society during the hours they are open to members.

(*d*) To have personal access to the Library and other public rooms of the Society, and to examine its collections.

(*e*) To take out books, plates and manuscripts from the Library.

(*f*) To receive *gratis*, copies of the *Journal and Proceedings* and *Memoirs* of the Society.

(*g*) To fill any office in the Society on being duly elected thereto.

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